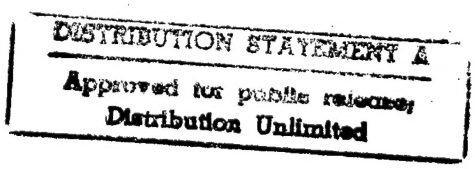
JPRS-JST-86-022

5 AUGUST 1986

# Japan Report

## SCIENCE AND TECHNOLOGY





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# JAPAN REPORT

## SCIENCE AND TECHNOLOGY

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ELECTRONICS

# VICE PRESIDENT OF SHARP DISCUSSES PROSPECTS OF INDUSTRY

Tokyo DENSHI in Japanese Dec 85 pp 8-17

[Article by Tadashi Sasaki, vice president of Sharp Corp.: "The Current Situation and Future of the Japanese Electronics Industry"]

[Text] Introduction

It gives me great honor to have the opportunity to talk about "the current situation and the future of the electronics industry" at the electronics industry technological convention which is proud of its long history and wonderful achievements.

Japan faces a very difficult problem in selecting its future course. Our electronics industry is no exception. Confronted with very severe situations, the Japanese industry must stand against violent waves. Therefore, I find it necessary to review the current situation of the Japanese electronics industry and probe the main problems with which we are currently confronted.

## 1. The Current Situation of the Electronics Industry

### (1) Creation of Leaders of Home Electronics Apparatus

The total output of the Japanese electronics industry in 1984 reached Y16 trillion. Compared with the previous year, this is an increase of 131.4 percent, showing a high growth rate following 134.7 percent in 1976. Considering the fact that the Japanese economy has shown a moderate growth rate ranging from 3 to 6 percent in substance for the past few years, this figure may be called a dramatic growth. In fact, the electronics industry's share of the GNP exceeds 5 percent, and is currently a leading Japanese industry ranking with the automotive industry.

Looking back at the transition of the composition ratio of the main business lines in the manufacturing industry, in 1950 the textile industry's composition ratio was overwhelming, exceeding 20 percent, followed by the steel industry. In those days, both the textile and steel industries were very popular. In the meantime, the automotive industry and the electronics industry shared less than 2 percent. However, both industries have made steady progress and have now plunged into the representative industries of Japan, replacing the textile and steel industries, which have been suffering from

pursuit by the developing nations. It goes without saying that the high-tech electronics technology and the use-oriented marketing force behind the dramatic growth of the Japanese electronics industry have maintained an international competitive power and have built up the foundation of the current propserity. (See Figure 1)

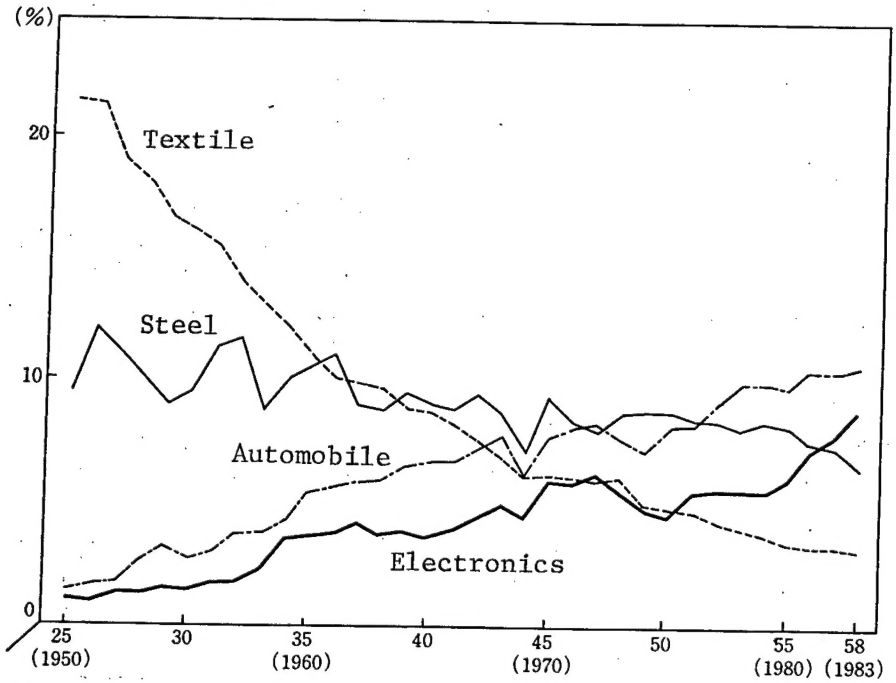


Figure based on shipping quantities in industrial statistical tables.
Electronics industry does not include office equipment.

Figure 1. Changes in Composition Ratio of Leading Business Lines in the Manufacturing Industry

The Japanese electronics industry is characterized by the fact that home electronics apparatus, industrial electronics equipment and electronic components have been well balanced in their development, marking steady progress. The industry's composition ratio, although subject to slight fluctuations for the past decade, has gradually come to be dominated by electronic components supplied to both the domestic and overseas markets. This signifies that the production structure of electronic components is becoming integrated or system-oriented. Therefore, these problems will be discussed in greater detail. (See Figure 2)

First, the output of home electronics apparatus in 1984 reached Y4.719 trillion, sharing 28.1 percent of the total output of the electronics industry. The growth rate of home electronics appliances compared with the previous year is 123.1 percent, and failed to reach the growth rate of 131.4 percent of the overall electronics industry. Nonetheless, the figure indicates a high growth rate. The prime mover for this marked expansion is greatly attributed to the

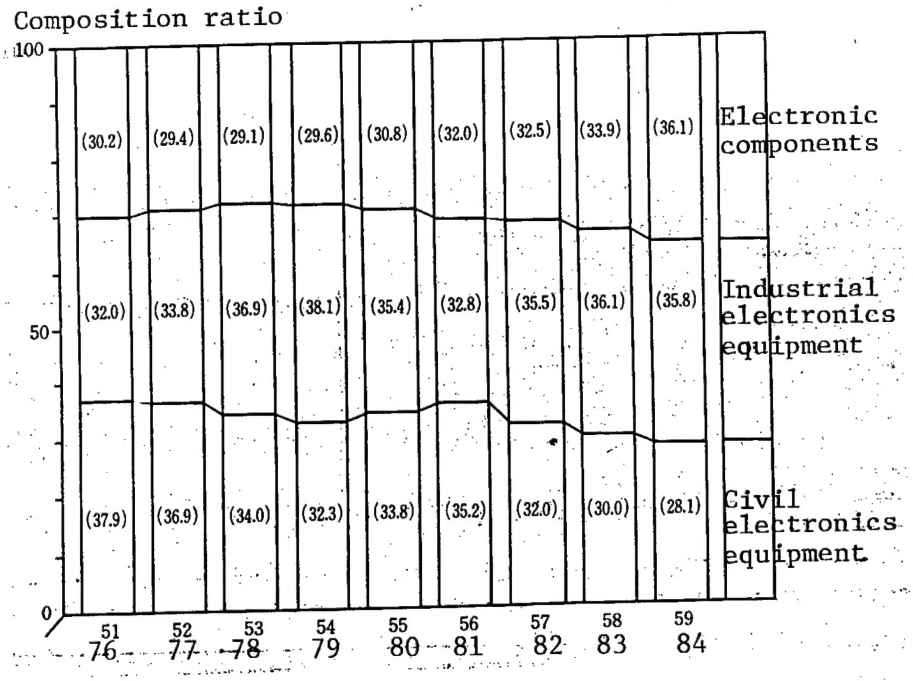


Figure 2. Changes in Production Composition Ratio Per Field in the Electronics Industry

popularity of home VTR's, sharing as much as 44.3 percent of the output of home appliances.

Home appliances have always included leader products which dominate the market. For example, black and white TV sets in the 1950's, color TV sets in the 1960's, and audio products in the first half of the 1970's were leaders in their respective time periods. In the meantime, home VTR's replaced these positions in the latter half of the 1970's. The electric washers and refrigerators which were created and widely distributed from the 1950's to the 1970's dramatically released many housewives from the burden of chores on which they used to spend 10 to 14 hours every day before these electronic home appliances were introduced. This helped housewives find their own leisure time. Furthermore, the creation of black and white television sets, color television sets, and audio products began inspiring many housewives with an idea "let's enjoy our daily life with more comfort and culture," and thus contributed to the elimination of regional or time differences in the information culture. This is a well-known fact that no one can deny. It goes without saying that the cultural benefits were not confined to the Japanese people alone, but were exported all over the world in compliance with the export promotion policy advocated by the government, and greatly contributed to improvement of the living culture of the whole human race.

Since home VTR's which predominated the latter half of the 1970's were originally developed, marketed, and supplied to the world market by Japan, their production in 1984 amounted to 28.61 million units, of which 77 percent was exported. As for destination, 11.91 million sets, double the figure of the

previous year, were exported to the United States due to the opening of the Los Angeles Olympic Games. This shows the most striking feature compared with the previous leaders. However, home VTR's, which made a dramatic growth, have begun a slowdown in growth rate this year, now heading for a course for stable growth. It is highly expected that video disks, audio disk players, etc., will become the subsequent leaders.

The export of home electronics appliances in 1984 amounted to Y3.306 trillion, which shares 70 percent of the output. (The export of home VTR's amounted to ¥1.62 trillion.) The destination of export comprises the United States (50.9 percent), Europe (22.2 percent), and Asia (18.6 percent), in that order. In recent years, neighboring Asian countries such as South Korea, Taiwan, and Hong Kong have been catching up with Japan. Canada experienced a dumping problem of South Korean color TV sets. The electronics industry is the field which Japan can be proud of regarding its international competitive power, which has been built up by accurately recognizing needs in the destination of exports and carrying out the strictest quality control with delicate and thoughtful consideration to design, configuration, operability, and safety. In addition, the efforts to reduce production costs by introducing the most advanced LSI or sensor techniques have made Japan the supply base for the world market. However, as the Japanese electronics industry increases its share in the world market and enhances its international position, our industry must exert the leadership concerning standardization problems.

The standardization problem involves many difficult factors. For example, the conventional approach to standardization which has often been observed in the past is a "catch up" method where standardization starts after products are marketed. In the stage of international standardization, very few countries are interested in active participation in the international standardization problems, such as ISO or IEC, and are reluctant to accept the task of a managing country or to offer counterproposals, if any. As for the Japanese electronics industry, we often play second fiddle to Europe and America.

It goes without saying that standardization never spoils the originality of technological development. However, technical specifications are subject to diversification and sophistication as well with the background where technical innovation is accelerating total or integrated systems. In addition, investment in the stage of R&D often demands greater cost and longer periods of time, increasing overlapping investment or risks. Furthermore, the demand for promoting further standardization, coupled with the sophistication and diversification of products, is also expected to be voiced more and more from users. From the standpoint of maintaining interoperability, we are trying our best to cooperate with our government to set up guidelines for national standardization or international standardization organizations. When drafting international standards, we are also studying various approaches so we may accept the position of a managing country or take the initiative to propose our standardization planning. In the field of Japanese home electronics appliances, we must realize the international position or role thoroughly, and hence continue further efforts to establish international standardization.

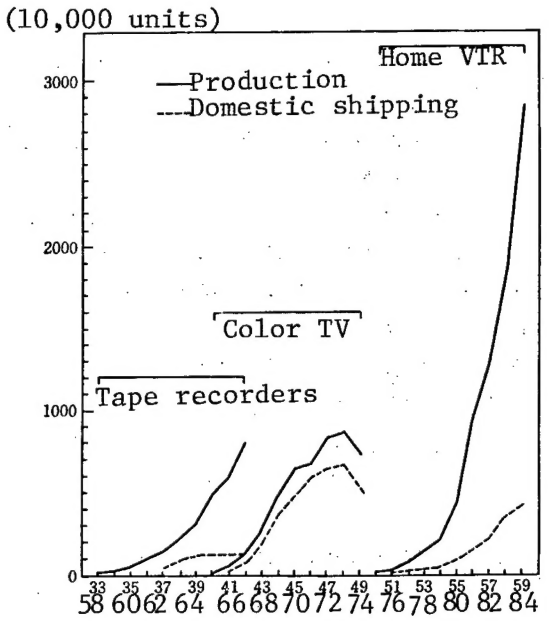


Figure 3. Growth Comparison for Leading Products

Data source: Production = Dynamic production statistics by the Ministry of International Trade and Industry
Domestic shipping = Japanese Electronics Machine Industry Institute

Now Japan is approaching an "advanced age" society. The widespread application and promotion of home electronic appliances have increased the opportunity for the aged or children to come into contact with electronic equipment or appliances. We must exert our efforts to eliminate any possible chance for a generation gap when operating electronic equipment or apparatuses. Otherwise, the failure will produce a cultural gap between generations which may delay the wide application of home electronic appliances. Command of equipment handling will produce satisfactory effects on the application of equipment. Therefore, the man-machine interface, which can be handled by men and women irrespective of age or locality, is absolutely necessary. From the standpoint of ergonomics, engineers should study every possible point such as psychology, color, and habit, and then design such equipment that is not only easy, but also pleasant to handle. This is a responsibility which must be shared by the engineers. Then, I would like to discuss industrial electronic equipment.

(2) Overseas Dependent Qualitative Industrial Equipment

The output of industrial electronic equipment in 1984 amounted to ¥6.004 trillion, 35.8 percent of the production of the electronics industry. It made a dramatic growth of 30.5 percent compared with the previous year. The industrial electronics equipment comprises radio, cable communications equipment, electronic application apparatus, electronic measurement instruments, and business machines. The electronics application apparatus enjoys the

greatest share of ¥3.364 trillion, thus having made rapid progress by 140.7 percent compared with the previous year and maintaining double digit growth for 8 consecutive years. In addition, radio and cable communication equipment amounted to ¥1.754 trillion, thus communication equipment amounted to ¥1.754 trillion, thus indicating 119 percent of growth compared with the previous year.

A look at the past record of exports and imports of industrial electronics equipment reveals that 43 percent of the production, which amounted to ¥2.457 trillion, was exported, while imports amounted to no more than ¥368 billion, thus indicating a substantial excess of exports. The figure includes exports of foreign companies. It is true that the above record resulted from efforts to develop the market and from an accurate grasp of consumers' needs. It is also attributable to the fact that our efforts to produce high-quality and high-capacity products are recognized by the dealers in the industrial electronic field and by users, and hence are accepted by foreign countries, but it must be admitted that the Japanese electronics industry has an export dependent constitution.

The electronics industry has been the field of which the United States could be the most proud, forming a quarter of the high-tech industry such as electronic computers and communication equipment. However, Japan has made dramatic progress even in this field. The output of electronic computers and related devices included in the electronic application devices in 1984 amounted to ¥2.811 trillion, indicating 143.7 percent growth compared with the previous year. This figure included personal computers, office computers and related devices that had been excluded from the dynamic production statics compiled by the Ministry of International Trade and Industry [MITI] up to 1983. From the standpoint of time series, the output of the electronic computers excluding the above two products indicates 124.6 percent growth compared with the previous year, maintaining double-digit growth for the 9 consecutive years since 1976. According to the record of exports and imports, 38.7 percent of the output, which amounted to ¥1.086 billion, was exported, indicating a growth of 159.9 percent compared with the previous year. This is also double-digit growth which has continued for 7 consecutive years. On the other hand, the import volume amounted to a mere ¥220 billion. The figure also indicates the excess of exports. When domestic output and the import and export value are added and subtracted, domestic demand amounted to ¥1.945 trillion, indicating the popularity in the electric and mechanical industries, and the financial world as well. (See Figure 4)

In contrast to such a marked hardware expansion, the sales of software in 1984 amounted to a mere ¥51.2 billion, indicating an increase of 10.2 percent compared with the previous year. Although the sales of software are gradually increasing year by year, they are far from those of Europe and America, creating a serious problem for the information age. The number of software engineers in the total industry is estimated to be 40,000 for the present. When the number of computers installed and the operation situation are reviewed, the number of software engineers is not sufficient, indicating a critical situation. (See Figure 5)

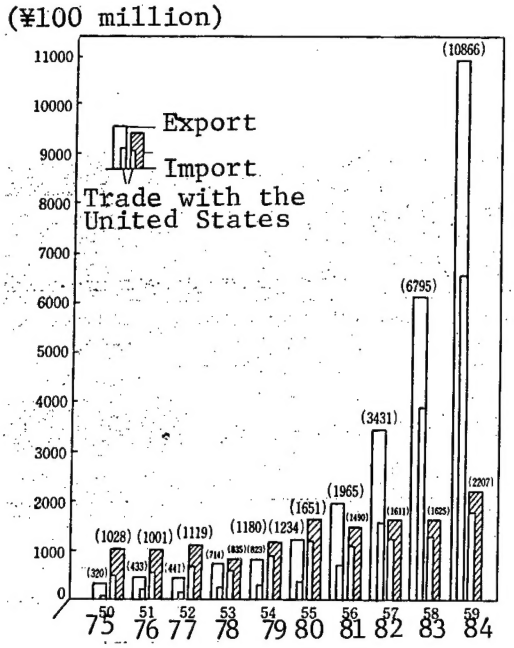


Figure 4. Changes in Export-Import of Electronic Computers

Data source: Originated from customs statics by the Ministry of Finance

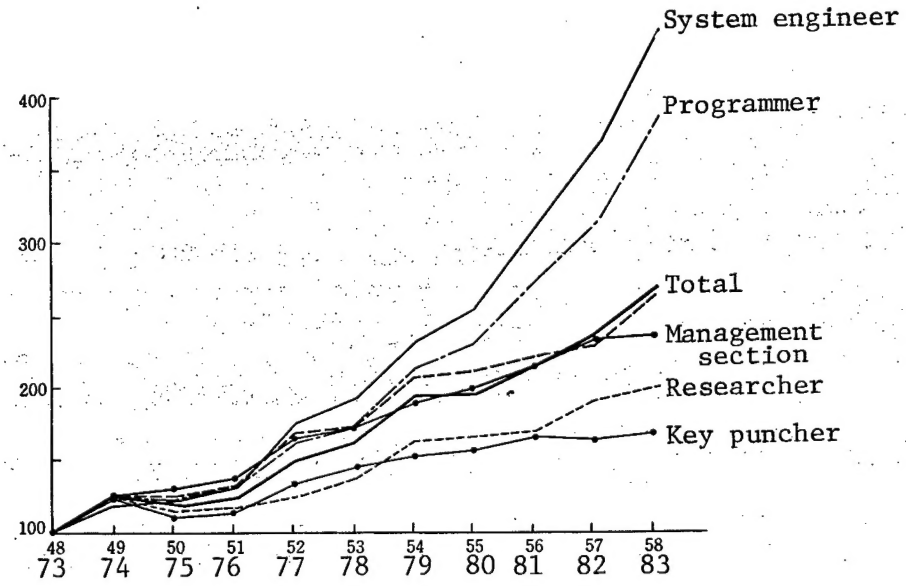


Figure 5. Changes in the Number of Personnel Engaged in the Information Processing Industry (1973 = 100)

Prepared from the data "Investigation Into Factual Situations of Special Service Industry" by MITI

About 7 years ago, (E.D. Jones) of the Stanford Research Institute in the United States predicted the population of software in the world. According to his prediction, "the software population would exceed the world population in 2025." His statement was quite shocking and much talked about. Apart from the future of 40 years, even MITI predicted that "the demand for software will grow at an annual rate of 26 percent, while an increase in software productivity is expected to be merely 4 percent. Software engineers are expected to grow at an annual rate of 13 percent. In 1990 the shortage of software engineers will amount to 600,000, which will bring about a serious software crisis."

To comply with the above situation, various measures are now being taken. They include software industrial system planning (Sigma project), promotion to introduce computer training in the curriculum of elementary and secondary education and maintenance of interoperability. At any rate, the preparation of software often demands many hands, and furthermore, is associated with the management strategy or business expertise of enterprises, which constitute a serious aspect. This is the problem Japanese industry must solve with its strength. (See Figure 6)

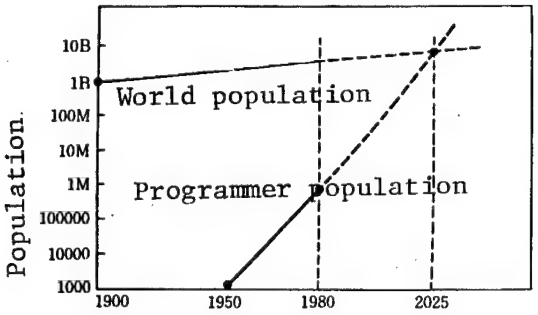


Figure 6. Forecast of the Increase in the Population of Programmers

Note: Population unit: M stands for million and B represents billion

Data: From (E.D. Jones), SRI, 1978.

(3) IC Greatly Affects Other Industries

Then I would like to discuss the electronic components which have increased the importance of their roles in the electronics industry. The output of electronic components in 1984 reached ¥6.533 trillion. This figure is indeed about 5.5 times that of 1975. Especially, semiconductor components and IC's (integrated circuits) are the most popular and important electronic components. The output of semiconductors and 1C's in 1984 amounted to ¥2.584 trillion.

A look at the world IC map shows a rough classification of market share in the world. For example, the United States shares 60 percent, Japan 30 percent, and others 10 percent. In the domestic market, the demand structure for IC's comprises 37.1 percent of home electronic appliances, and 62.5 percent of industrial equipment. Out of the home electronics appliances, VTR's, which

share 14.3 percent of the demand, are the most popular, followed by audio products, which share 8.6 percent of the demand. As for industrial equipment, personal computers and word processors share 16.5 percent of the demand and electronic computers and terminal equipment, 14.3 percent. The input coefficient of IC's to electronics equipment rises every year, indicating an upward tendency in the future. IC's have contributed not only toward "keihaku tansho," or the effort constantly to make the equipment thinner and more compact, but also toward the reduction of resources and energy. Furthermore, IC's have promoted the lowering of the cost and formed the basis for the creation of multifunctional and highly efficient electronics equipment by their high reliability. The waves of electronization have greatly affected other industries, such as the automobile and robot industry, thus contributing toward the promotion of all industry. This is the greatest honor and pleasure to us who are enaged in the electronics industry.

According to the current situation, the demand for IC's is moving from the 64K bit class to the 256K bit class. The line width is now about 1.2 μm. In the near future, they will become highly integrated and higher density-oriented such as 1M, 4M, and 16M bits. The technological R&D is being carried out by changing the current electron beam technique to the molecular beam exposure technique. According to current R&D, the cell-to-cell width is 0.25 μm or "quarter micron." In addition, active R&D for optical IC's or three-dimensional IC's are making progress.

The proven record of IC exports and imports in 1984 shows that exports amounted to ¥776.8 billion, 39.4 percent of the IC production of ¥1.974 trillion. The export of IC's to North America amounted to ¥373.36 billion, which is equivalent to 48.1 percent of the total exports. I believe this figure is attributable to the U.S. business recovery from the fall of 1983 through the spring of 1985, demanding more and more IC's. On the other hand, the import of IC's from overseas amounted to a mere ¥22.22 billion. And 75 percent of this is export from North America, amounting to ¥16.69 billion, thus indicating a tendency to lower the degree of import dependence. The difference between the Japanese semiconductor industry and the U.S. semiconductor industry lies in the fact that in Japan the overall electronics makers are mostly engaged in the production of IC's, while in the United States the IC makers are engaged in the production of IC's in most cases, and are easily subject to general business trends and highly dependent on overseas production. This forces the degree of imports from overseas to increase in the United States. The United States partly leads the field of production, even 5 years ahead of Japan, and is proud of its high-tech industry, which must be a factor in the current semiconductor friction between Japan and the United States. (See Figure 7)

Now that I have briefly stated that the main points which affect the factual situation of the Japanese electronics industry and the main products based on the record of 1984, I just wonder if Japan is the only nation which has made such dramatic progress as discussed so far. I would like to examine the movement of the electronics industries in the advanced countries based on data which are rather old due to the statistics available. Their electronics industries in 1983 expanded by 113.5 percent compared with the previous year, while the Japanese electronics industry indicated a growth rate of 121.8

| | | 1981 | Compared with the previous year | 1982 | Compared with the previous year | 1983 | Compared with the previous year | 1984 | Compared with the previous year |
|---|---|---|---|---|---|---|---|---|---|
| Production | (A) | 668,754 | 120.8 | 834,883 | 121.2 | 1,139,523 | 136.5 | 1,973,850 | 173.2 |
| Imports | (B) | 114,253 | 105.0 | 127,382 | 111.5 | 152,602 | 119.8 | 222,176 | 145.6 |
| Exports | (C) | 199,640 | 108.9 | 285,112 | 142.8 | 423,836 | 148.7 | 776,775 | 183.3 |
| Domestic market | (D) | 603,367 | 121.7 | 677,153 | 112.2 | 868,289 | 128.2 | 1,419,251 | 163.5 |
| Import from the United States | (E) | 70,488 | 101.3 | 83,494 | 118.5 | 107,605 | 128.9 | 163,619 | 152.1 |
| Percentage of import from the United States shared in domestic demand | (F) | 11.7 | | 12.3 | | 12.4 | | 11.5 | |

(Notes) 1. Domestic market (D) = A + B - C
2. Domestic demand ratio with the United States (F) = E/D

Figure 7. Exclusive Ratio of Domestic IC Market and Imports From the United States in 1984

percent. However, when reviewed in terms of value, Japan increased by merely $9.5 billion, while the United States expanded by $16.4 billion. In terms of the classification of products, Japan expanded the industrial equipment and electronic components, while the United States exceeded both Japan and Europe in home electronics appliances. This may reflect the economic situations in the regions or the national characters concerned.

Over the past 10 years Japan has gradually increased the weight of the electronics industrial products which share the total volume of Japan's exports and imports. In 1984 the electronics industry shared 22.3 percent, although voluntary restrictions were placed on car export to the United States. Ever since the initial oil crisis, Japan has exerted all efforts to automate the production facilities and strengthen TQC, trying to strengthen its nature and competitive power along the national policy of "founding the state on the basis of trade." This is the reason Japan has produced such wonderful results. On the other hand, the United States has tried to seek its production foothold overseas, neglecting efforts to invest in domestic production facilities due to the high interest policy of the United States Government. These factors are responsible for having weakened its international competitive power. The import and export balance of the Japanese and U.S. electronics industries amounted to ¥1.25 trillion in 1982, ¥2 trillion in 1983, and ¥3 trillion in 1984, thus producing a dramatic imbalance between Japan and the United States and incurring serious trade friction.

2. About the Economic Friction Between Japan and the United States

(1) Concentrated Offensive Against Japan

The economical friction involves various factors such as GDP, the exchange rate, international money and banking, interest and trade balance. It also involves very sophisticated factors which cannot be solved by Japan and the United States alone because of the current internationalization of the world economy. First, I would like to review Japan's trade balance. (See Figure 8) In 1984 Japan did not increase the import of petroleum due to the progress in energy saving and the drop in the dollar-based price. On the other hand, Japan maintained a high level of export due to the high dollar, sustaining a surplus in the balance of trade of $35.1 billion. Japan's trade surplus with the United States amounted to $35 billion, and recorded $9 billion with the EC, which enjoyed a relatively upward trend, and $2.4 billion with communist China, which was in a hurry for modernization. On the other hand, Japan recorded an import surplus with the Middle East, Canada, and Australia. When the world trade balance is reviewed, it is found that only Japan enjoyed a most striking trade surplus. Japan's trade surplus of $35.1 billion was about equivalent to its trade surplus of $33.8 billion with the United States, which suffered from sluggish business conditions after the Olympic games, the presidential election and the budget deficit. Furthermore, the high-tech industry of which the United States can be proud is subject to the import offensive from Japan. These factors caused the economic friction against Japan to erupt at one stroke. More than 300 sanction bills against Japan are currently before Congress. The main bills include an import surcharge on Japan, voluntary export restrictions, correction of unfair trade practice

(Unit: $ million)

| | World | United States | EC | South-east Asia | China |
|---|---|---|---|---|---|
| 1980 | Δ 5,919 | 7,519 | 9,743 | 60 | 1,091 |
| 1981 | 9,204 | 14,401 | 10,211 | 2,328 | Δ1,061 |
| 1982 | 9,328 | 12,211 | 9,923 | 2,623 | Δ1,647 |
| 1983 | 23,328 | 21,029 | 10,131 | 6,540 | 117 |
| 1984 | 35,091 | 33,832 | 9,971 | 4,887 | 2,389 |

Figure 8. Japan's Trade Balance Per Country

Remarks: (1) Originated from "Foreign Trade General Situation" by the Ministry of Finance.
(2) The figures represent the customs balance.

(Commerce Act Article 301), reduction of customs tariff and elimination of nontariff barriers, thus provoking further protectionist sentiment. Against these accusations, Japan is trying to refute that "the current trade imbalance is attributed to the high dollar and low yen. U.S. enterprisers' efforts to develop overseas markets are less active. Japan's market is not as closed as it is often accused of being." At the same time with these refutations, Japan is trying to solve these problems by taking various measures such as the Action Program, the promotion of imports, and the expansion of domestic demand, while the United States is also trying to correct the high value of the dollar and its high interest policy and to remove the budget deficit. Both the Japanese and American business worlds are exerting all possible efforts to adjust to the deficit.

(2) Is There Any Proper Countermeasure Available To Correct the Trade Imbalance?

Dr Akira Onishi of Sokka University presented the results of his simulated study based on the world economy model in the magazine ECONOMIST. I would like to quote part of his article.

The world economy model used here classifies the world economy, which comprises the advanced economy market, the developing market economy and the central planned economy, into 54 main nations and 8 regions and interlocks these models internationally. It is used by the United Nations for the scenario to forecast the international development policy. (See Figure 9)

Scenario C is based on the assumption that the value of the dollar will become 10 percent lower than the standard forecast starting with 1986. The decline of the dollar raises the import price of the United States, and then the consumers' prices by 1.9 percent in 1986. Therefore, the nominal wages as well as the export price level will also rise, which increases the expectation for inflation since the primary product prices are moving up strongly. The U.S.

o Scenario A--Under the assumption that Japan makes no dramatic change in its policy (standard model).
o Scenario B--If all goods imported from Japan are charged a 25-percent surcharge.
o Scenario C--If the high value of the dollar is corrected by 10 percent.
o Scenario D--If Japan continues its high growth of 10 percent.

| | Economic growth rate | Current account balance of payments | Trade balance with Japan | Others |
|---|---|---|---|---|
| Scenario A | United States:<br>Annual rate of 3.4 percent from 1985 to 1990<br>Japan: GDP<br>Annual rate of 4.5 percent | United States:<br>1985: $128 billion<br>1990: $148 billion<br>Japan:<br>1985: $ 37 billion<br>1990: $ 67.7 billion | 1985: $42.3 trillion<br>1990: $60.4 trillion | GDP annual rate from 1985 to 1990<br>Entire world 3.6 percent<br>Markets for advanced countries 3.1 percent<br>Markets for developing countries 3.1 percent<br>Central planned market 4.8 percent |
| Scenario B | United States:<br>Annual rate of 0.54 percent from 1985 to 1990<br>Japan:<br>Annual rate of 0.15 percent from 1985 to 1990 | United States:<br>1987: $ 11.5 billion<br>1990: $ 19.7 billion<br>Japan:<br>1987 $ 3.8 billion<br>1990 $ 5.1 billion | 1987: $ 4.4 billion<br>1990: $ 4.5 billion | Annual rate from 1985 to 1990<br>Asia NICS 0.24 percent<br>Latin America 0.44 percent<br>EC 0.06 percent |
| Scenario C | United States:<br>Annual rate of 0.42 percent from 1985 to 1990 | United States:<br>1987 $ 3 billion<br>1990: $ 9 billion | 1986: $ 5 billion<br>1990: $ 1.9 billion | |
| Scenario D | United States:<br>Annual rate of 0.17 percent from 1985 to 1990<br>Japan:<br>Annual rate of 5.5 percent from 1985 to 1990 | United States:<br>1986: $ 1.5 billion<br>1990: $ 8 billion<br>Japan:<br>1986: $ 6.7 billion<br>1990: $ 39.6 billion | 1986: $ 1.4 billion<br>1990: $ 5.7 billion | Annual rate from 1985 to 1990<br>Entire world 0.55 percent<br>Markets for advanced countries 0.81 percent<br>Markets for developing countries 0.15 percent |

Scenarios B, C, and D show increase and decrease over Scenario A.

Figure 9. Simulation Based on World Model

interest charge is expected to rise by 0.4 percent in 1986, and by 0.9 percent in 1988 thereby producing a paradoxical phenomenon where the dollar's weakness will push up export prices. Since the dollar's weakness raises the export and import prices of the United States as well, the nominal exports will rise at an annual rate of 3 percent on the average, while nominal imports will rise by 0.49 percent. However, the trade deficit of the United States will decrease to $19.5 billion conversely due to the effect in 1987, and an improvement of only $9 billion can be expected in 1990. The U.S. trade deficit with Japan will increase by $5 billion in 1990, and by $1.9 billion in 1990 [as published]. Therefore, the correction of the high dollar will not be useful to correct the trade imbalance between the United States and Japan. The dollar's weakness raises U.S. domestic prices while conversely the high value of the yen inhibits the rise of Japanese wholesale prices which prevents the competitive price strength of Japanese export sales with the United States from falling.

Scenario D is prepared under the assumption that the domestic investment rate in 1986 is raised for domestic expansion and the real growth rate is increased by about 5 percent on the average. In other words, it is assumed the annual growth rate of 10 percent on the average will be maintained over 1990. The annual growth rate of the world economy will rise by 10 percent on the average due to the high growth of Japan. The expansion of plant investment will improve the value added productivity, while it will lower the wage cost conversely, thus maintaining the stabilization of the wholesale prices. In addition to the above effects, Japan's high growth enhances expenditure for R&D and promotes investment expansion in the field of high technology thereby developing its competitive power in this field. On the other hand, the U.S. high-tech industry is subject to a negative impact, and the U.S. growth rate will decline at an annual rate of 0.17 percent on the average over 1990. Although the expansion of domestic demand in Japan is expected to improve the trade imbalance by $1.4 billion in 1986 and by $5.7 billion in 1990, the trade imbalance between Japan and the United States is likely to remain at the high level of $54.6 billion.

In addition, many simulations such as the nontariff barrier have been carried out, but many are lacking in immediate effect, and the correction measures are subject to their limitations as long as they are prepared based on the current market mechanism as a precondition. It is concluded that the solution of these problems requires a long period of time and much patience to tackle them.

Every country has its own specific export-import lines, consumption inclinations, consumption structure, and social compensation system. They also react differently to changes in such main factors as incomes, inventories, and relative prices. These are called "elastic values." The import elastic value with the income factor is specified as 0.76. Especially, the elastic value for imported raw fuel is 0.24 based on an effort to save energy. The elastic values for foodstuffs is 1.35 while the elastic value for industrial products is 1.94, respectively. The Japanese people cannot take meals five times a day just because the elastic value for foodstuffs is simply higher. To solve this problem, Japan must try to expand the import of industrial products.

The whole nation of Japan is now exerting all its efforts to eliminate the economic friction between Japan and the United States and maintain its mutual friendship by taking every possible measure, such as expansion of domestic demand. The movement which is actively being conducted by Japan to eliminate the trade friction includes overseas investment and contributions to ease the unemployment rate and increase the GNP of its counterpart country. However, we must understand that such overseas advancement (in the developing countries) based simply on the maintenance of marketing channels and cheap labor cost will fail to solve various problems such as the improvement in their national strength and productivity sooner or later. Even if they wish to manufacture domestic products, they are obliged to import components from Japan in terms of product quality and delivery time. This is a reality which cannot be denied. The labor productivity, equipment capacity and quality control concept are different from each other. Japan's overseas net asset amounted to $74.3 billion toward the end of 1984 due to the U.S. high interest policy over long periods and the overseas advancement by Japanese enterprises. This involves some dangerous misunderstanding that Japan wishes to colonize their countries economically. For the past, Japan has often been denounced as "a big power-oriented" country, arousing anti-Japanese sentiment which may develop into an anti-Japanese movement in some cases.

Various kinds of demands for Japan have been voiced in addition to the trade imbalance correction stated above. For example, "since Japan is now an economic superpower, it must shoulder its responsibility as a superpower." It goes without saying that Japan must expand the official development assistance (ODA) toward the developing countries or those countries suffering from poverty. We must not forget that many countries desire technical assistance rather than monetary assistance. Dr (Harbebrooks) of Harvard University once criticized: "Japan should place emphasis on basic scientific research, which is the common asset of human beings. Japan has simply utilized the research achievement attained by the other countries under their tax payment."

Therefore, in the next issue, I would like to review the current situation of Japanese scientific technology.

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# LONG-TERM PLANS OF PROVINCIAL ELECTRIC POWER COMPANIES DISCUSSED

Tokyo TOSHI KEIZAI in Japanese Jun 86 pp 127-133

[Article by Takeshi Tamamura]

[Text] Chugoku Electric Power: Emphasis on Structural Balance of Sources of Electric Power

## Industry's First "Projection for Year 2000" Undertaken

With the objective of contributing information on how to cope with the radical social changes that are anticipated as the 21st century approaches, a "Projection to Year 2000 Investigative Commission" was created in July 1983. In November 1984 a concept paper entitled "Recommendations for the Approaching Year 2000" was prepared describing recommended long-term operational procedures pertaining to the various matters that the company will be involved in in the year 2000.

On entering the 1985-95 decade, it is appropriate that considerations be given to operational strategies to cope with the 21st century. The number of enterprises that are drawing up long range policy statements are increasing, but because this is the first one of its kind to tackle the 21st century in the electric power industry, it is attracting much attention not only from that industry but also the mass communication industry.

The above named commission starts off by describing Japan's economic society as it approaches the 21st century, and lists what it believes will be basic categories of subjects that will have a major impact on the company. It created eight working groups under it to consider and investigate assigned subjects and submit their findings to the commission for discussion. In undertaking the investigative work, emphasis was placed on how to visualize, how to think about, and how to capture for application the essential qualities of the changes that became discernible from the investigative efforts, rather than on the definitive analyses of the results. In the process, the commission dug into the status of other industries, collected opinions from within and outside of the firm. It spent over a year collecting such reference material and endless discussions were held before the report was compiled for the firm's consumption.

The company's "Recommendations for Approaching the year 2000" is composed of the following three sections: Section 1, Changes in Social Environment and Their Effects on the Company; Section 2, Essence of the Recommendations (How the Company Copes with the 21st Century); Section 3, The Four Pillars That Sustain the Recommendations.

In Section 1, assumptions are made that as the year 2000 approaches there are basically seven trends to enhance internationalization--software, information, seniority, variety, decentralization, systematization. The many-faceted effects that these seven trends will have on the company are fully discussed.

In this issue, however, we have decided to introduce the reader to Section 2, "Essence of the Recommendations" because they will become the major points in the company's operational development in the future.

Problem Areas in Approaching 21st Century and Coping With It

The eight working groups subordinated to the "Projection to Year 2000 Investigative Commission" are: Best mix; electric power supply system; new media; information system; energy requirements; community; work amenities; regional outlook. Each working group estimated the effects of environmental changes on its individual category, and how best to cope with them.

Of the essential points in the recommendations section, point number one was "assembling an electric power source structure that has a good balance between security and cost and to incorporate new energies aggressively." In other words, giving appropriate consideration to the stability and economic factors in supplying electric power, the plan calls for nuclear energy, coal, and other source materials on a one-third-each basis.

In FY 1985, the ratio of the sources of electric power generation were (estimated): coal, 42 percent; nuclear, 8 percent; hydro, 10 percent; gas, 12 percent; oil, 28 percent. Currently under construction are No 2 at Shimane Nuclear Generator Plant (output, 820,000 kilowatts; scheduled to become operational in February 1989); No 1 and No 2 hydroelectric generators at (Matanogawa) Power Plant (output, 300,000 kilowatts each; scheduled to become operational in October 1986 and October 1987); thermal sources include No 1 and No 2 coal fired generators at Shinonoda Power Plant (output, 500,000 kilowatts each; scheduled to become operational in April 1986 and February 1987). In addition, electric power development projects at three sites using coal, LPG [liquified petroleum gas], heavy oil, and LNG [liquified natural gas] as thermal energy sources, are proceeding at full speed.

In 10 years, or in FY 1995, the electric power sources are estimated to be structured as follows: (in output power) coal, 42 percent; nuclear, 16 percent; gas, 22 percent; hydro, 10 percent; oil, 10 percent.

Paralleling this electric power source development project, research and development into placing fuel batteries in which much expectations for high thermal rate effectiveness is placed, at decentralized power generating sites is being undertaken. Every effort will be made in research and development of

fuel batteries, solar generators, cogeneration equipment (combining electric power and thermal energy).

The second point in the recommendations was: "Improve the quality of electricity and make facilities more environmentally harmonious." This requires that the nature of electricity be made more responsive to society's needs, flow more efficiently and improve the operational system through more efficient systems.

Concerning environmental improvements, power delivery and transformer facilities in metropolitan and peripheral areas, cables will be put underground and unsightly equipment and facilities will be "greened." In the central city areas, considerations will be given to putting the power lines underground and take other measures compatible with the immediate surroundings while being aware of matters pertaining to costs.

The third point: "Build a Companywide Information System and Cooperate in Building a Regionwide Information Structure." This will enable a review of duties and simultaneously, on line dispositions, promote office automation [OA], and installation of computers in consonance with work loads and objectives. For the purpose of installing a companywide information system, information distribution facilities will be enlarged and an optic fiber communication net will be structured; advancement of information facilities within the company is expected to contribute to the information banks of the Chuyoku region by distributing technologies and intelligence stored in the region.

Point No 4: "Coping with environmental changes caused by competition among energy producers through marketing techniques." Marketing techniques should become the strategic foundation of the future. They should be applied to determine consumer needs, and complement market surveys to determine the optimum distribution of obligations between supplier and consumer. They should be applied to develop the most effective equipment and tools, and to research for the optimal system. Findings from such studies should be made available to the consumers to broaden the base of their selection.

Point No 5: "Invigorate community activities to establish closer ties with the region." The intent here is to cooperate with administrative and economic organizations and offer personnel, materials and information in behalf of regional promotion. Of particular importance is the growth of cultural awareness and familiarity with the extraregional areas while establishing closer ties in intraregional areas while establishing closer ties in intraregional relations.

Point No 6: "Creation of attractive work areas and the acquisition and training of adequate manpower reserves." The intent is to have an assured pool of manpower capable of adequately serving a more highly educated society with greater professional levels of skill. Considerations should be given to part-time employment and other various forms of employment structures. At the same time personal history forms should be reviewed, and other steps taken to reflect the proliferation of values to offer better guides for personnel selection.

The "Regional Outlook" group had a different focal point from that of the above six groups; it selected subjects that pertained to the positions and developments in the Chugoku region which is basic to the company's existence.

Basic to its recommendation, it suggests: "Let us build a vital Chugoku region through the collection of intellectual brilliance and strength that is native to the region." The following are listed as the main points under this heading: (1) Development of a broad range administration; (2) The realization of a new era for the Seto Inland Sea area through the coexistence of raw materials industries, oceanic developments and tourism; (3) Full use of multidimensional traffic facilities, implementing strong developmental actions to give more prominence to the Sanin and interior areas.

"Essences of Recommendations" were compiled individually by the eight working groups and, therefore, are opinions independently arrived at from their respective standpoints. When all of these are consolidated and coordinated, the "Four Pillars" become clearly discernible.

The four are: (1) Being the responsible agent for the region's energy sources, (2) Conducting operational activities based on opportunities offered by such contacts, (3) Aggressive restructuring to meet new technological innovations, (4) Developing new operational resources. These are not new categorical subjects for the company, but as the 21st century approaches, they seem to take on even more importance.

The recommendations for the year 2000 do not end with the above recommendations. Currently, this part has been divided into four sections working toward the production of recommendations independently. The four sections are: marketing techniques; developing human resources; supply structuring for big urban areas; and creating an overall, consolidated information system.

With these recommendations as a starting point, the Chugoku Electric Power Company is programming its operations, keeping the 21st century in sight.

Hokuriku Electric Power Company: Progress Being made in Scenario for 21st Century.

The Hokuriku Electric Power Company is drawing up its "Operational Scenario for the 21st Century" with 2010 as its target year.

Directing itself to the 21st century, society is being confronted with a historic turning point that presses for revolutionary structural changes. Society's demands on the electric industry are expected to be at a higher level and more variable.

Visualizing a highly volatile economic environment for the 21st century, the company's basic operational policy is to fulfill its mission as an energy industry with foresight and imagination, to establish operational bases befitting the times. At the same time, it is prepared to assume the responsibilities pertaining to new regional industries.

In the scenario currently being prepared by the company, the company is visualizing the approaching 21st century with maximal objectivity in considering problems it must overcome to formulate its future operational policies.

Fifteen years still remain before the advent of the 21st century. It is very difficult to forecast accurately what the social and economic situation will be at that time.

This is so because of lack of clarity and fluidity, but the following points come to mind as being basic to the tidal flow: (1) Advancements in internationalization; (2) technological reformation; (3) advancements in information sciences; (4) a services' orientation of the economy; diversification and fixation of the sense of values; (7) regionalization. The interaction of these various factors will bring about major changes in the economic society.

Naturally, these changes will have a great impact on the electric industry: (1) Competition among enterprises will become heated; (2) consumer and regional needs will become diversified and more sophisticated; (3) encouragement of higher technology operational procedures and greater provision of information; (4) the advanced concept of multitiered internationalization; (5) a restructuring of workers' thinking and approach to work.

Changes in those areas will undoubtedly give rise to fresh operational problems, but needless to say, the company is prepared to cope with them in an aggressive manner. The firm gives the following ways in which it expects to confront such problems.

1. Development of Business and Service Activities That are Appropriate to the New Age

The company is deeply rooted in the region, and has assumed development of the Hokuriku region as its own responsibility. It is planning to cooperate in regional promotion as a means of reenforcing the basis for demands.

Coping with the heated competition among energy producers is bringing with it an era of selectivity. This will call for varicolored marketing strategies that will meet the highly diversified and high tech needs of the potential customers.

In other words, (1) aim at the development of a "high tech" area along Hokuriku roads, and leading technological industries will be recruited to come into the region; (2) Plan regional promotion by offering technological information to enliven industrial prospects; (3) In an effort to search for conditions that would be of mutual interest to both suppliers and consumers, a solution means to leveling out the consumption curve throughout the day is being studied with the aim of lowering the supply costs; (4) Give life to new safety regulations, and utilization of electricity to offer better living, and simultaneously develop and generalize new production systems to locate hidden sources of demand; (5) In response to the customer's needs, offer a

diversified scale of rates and give unstinting attention to even the smallest aspects of service.

2. Creation of Facilities That Most Suitably Meet the Demands of the Times.

The stipulations for designing electric power facilities for the 21st century are: assured supply stability; downward cost spiral; and pursuit of quality. These goals will be achieved by the induction of the best results of technological reformation in structuring the facilities.

(1) With regard to electric power source facilities, the company's first concern is the early materialization of the company's flagship installation, the Noto nuclear powered electric generator plant. With that as its breakthrough weapon, the company is strongly promoting diversification of power sources--nuclear and coal burning thermal--to lower electric power generating costs.

The policy to diversify its generator power sources by using nuclear power and coal burning thermal power is already being implemented. Application for the Noto nuclear powered generator No 1 (BWR [Boiling water reactor] type with maximum output of 540,000 kW) are being submitted to the Denchoshin [Power Development Council] in December. Work will begin in December 1988 and it will become operational in March 1993.

Preparatory groundwork on the sites for the Tsuruga coal burning thermal powered generator No 1 (maximum output, 500,000 kilowatts) and the LPG burning thermal powered Nanao Ota plant are to be continued this year.

The electric power supply structure in FY 1995 including the above described facilities under construction will show oil burning facilities down to 18 percent, with nuclear powered facilities at 23 percent, coal burners at 21 percent and hydro at 34 percent. These figures indicate major advancements in diversification of power sources. The company's strategy is to continue to study the energy outlook for the approaching 21st century and after ascertaining the developments in new electricity generating technologies, respond with the most suitable source structure.

(2) With regard to circulatory facilities, the economic society in the midst of better information distribution systems and higher degree of automation upping the customer's needs for higher quality electricity. Efforts are directed to make the reliability factor in supplies even greater through the maximum utilization of the ongoing technological reformation.

To achieve these goals, base electricity sources will have to have the capability of delivering a large capacity of power over a long distance with complete stability. This requires that the mainlines will have to be capable of handling electric pressures of 500,000 volts. In local and tributory systems, bidirectional electricity sources are encouraged as a means of minimizing power outages caused by electrical storms, snow and other natural phenomena. When an outage occurs even after every preventive measure has been taken, efforts are directed to minimize the affected area and to restore service as soon as possible by automated distributional switchings. Power

delivery, transforming and distribution will be a coordinated and consolidated to present a system of great reliability.

(3) Environmental considerations will demand the beautification and concentration of electric power delivery and transforming facilities. To keep in step with advancements into urbanization, power lines will undoubtedly have to go underground.

3. Advancements in Technological Development To Greet the New Century

While making every effort to meet the developmental needs with technological development activities that form the motivational power for future entrepreneurial expansion, connections with related organizations will be intensified toward maximal incorporation of hardware and software technologies.

From the standpoint of improving developmental effectiveness and reenforcing its technological base, the company is planning to participate aggressively in cutting edge technologies and large-scale technological development projects. Simultaneously, it plans to reconstitute existing technologies to better conform to regional characteristics and to systematize them, and incorporate them into the main body. Research and development projects will be undertaken that involve solar optic electric generation, fuel batteries, and other new electricity generating technologies; technologies that contribute to improved reliability factors such as electric storm damage prevention, and facilities and equipment diagnoses; technologies that contribute to lower costs such as new engineering methods, computer designs, and development of various types of software. Major emphasis will be placed on technologies leading to effective utilization of electricity such as those listed above, aimed at usefulness in production systems and living conditions as operational problems that must be overcome, and that are befitting developmental progress of the region.

4. Structuring a Comprehensive Operational Information System

With the upgrading of information processing technologies in the future, and with consideration given to advancements in information network structures, an online operational comprehensive information system aiming at a higher level and an increased efficiency of operations by coordinating plans control, production distribution, and operations into a single system is planned.

One of the above mentioned items is to further enhance the development of the administrative system, and to cope with increasing complexity and multiplicity of operations, the development of system to aid in decision making, document control system, voucherless system, reference material distribution and collection system, and means of collating and consolidating them will be studied and applied.

To fulfill the aim of maximization of facilities utilization and controls, overall automation of facilities incorporating the most modern information delivery and control technology will be put in place on a continuing basis.

For the purpose of maximal effective utilization of the expected skyrocketing volume of information that will be made available as the 21st century is greeted, digital networks based on optic communications will be structured for upgrading the quality of materials delivered. To achieve the goal of firmly establishing a composite operational information system to be in step with the new age, administrative systems will be optimized, and by upgrading the operations support systems, and induction of various types of working robots and improved operational control systems, close informational contact with customers and outside organizations such as VAN [voice added network] will be maintained.

5. High Operational Motivation and Endemically Creative Operators

In order to cope successfully with the variety of problems in the operationally turbulent environment, it is of utmost importance that high operational motivation and free and creative operational procedures endemic to the region be installed, giving consideration to the employees' conceptual and working structures. It is essential, under these circumstances, that leadership be taken by a controlling supervisor to exhibit an entrepreneurial spirit in behalf of maintaining a pool of manpower rich in vitality and sensitivity. Efforts must be made to build an elite corps from type-T manpower to assure a fulfilled professional expertise to cope with the problems created in the new age suitably.

The company's internal organization is structured to enable advancements in research and development, and enhanced administrative procedures that are in consonance with its functions. Efforts will be made to form a cohesive and active organizational structure that will be able to respond to the customer's needs, and to have effective facilities operation controls.

The company is drawing up a scenario that visualizes broad changes as the 21st century is approached and is establishing firm basic policies of operations. It is preparing to respond aggressively to future needs as a regional energy industry and to fulfill its responsibilities to society.

Kyushu Electric Power: Operation Targets Sales of Electric Power Increase by 1.8 Times and Fourfold Increase in Capitalization

"Long-Term Operational Program" Envisaged in April 1985

In February 1984 the Kyushu Electric Power got started on a "think piece" concerning the direction its operational course should assume to cope with the 21st century. A "Long Range Operational Program Investigation Committee" was formed to draw up a scenario. A basic stipulation in its consideration proceedings was that "to the electric industry with a dozen or so years required for facilities construction, we are already close to the time frame for drawing up concrete plans for the 21st century; there is an element of urgency in an early decision as to direction of operations in the future."

For over a year after that investigative work was continued resulting in the compilation in April 1985 of the "Long-Term Operational Program" that describes the basic policy for the 21st century. This merely outlines the

direction of this basic policy and implementation will depend on subsequent concrete working programs.

The "Long-Term Operational Program" is divided into four major parts. Part 1: Socioeconomics in the 21st Century (status of energy: technological information and outlook for higher information systems). Part 2: Kyushu's Socioeconomics in the 21st Century (structure of socioeconomics in Kyushu and analysis of subject matter). Part 3: Operational Environment and Subject Matter Pertinent to the Company (changes in the status of energy; changes in the socioeconomic situation; technological reformation and advancements in high level information techniques). Part 4: Basic Policy Postures That Should Be Assumed by the Company for the 21st Century (long range energy supply and demand strategy; technology developmental strategy aimed at coping with regional promotions; operational policies, etc.).

In other words, having estimated the environmental changes that will be wrought, the scenario sets up the following four pillars as being basic to the concept: (1) stable supply of energy; (2) closely knit area for the region; (3) contributing to regional culture: (4) contributing through research and development. Having thus established its vision for socioeconomics for the 21st century, the company clarified the way it plans to cope with it.

This article addresses itself to the salient points of Part 4. (Basic Policy Postures That Should be Assumed by the Company for the 21st Century) because that is the motivational key to the company's future.

Forty-five to 50 Percent Nuclear Powered Electric Generation

The long range outlook for economic growth in Kyushu is estimated at 4.4 percent (1980-2000). On that premise, electricity sales volume would be 70 to 79 billion kilowatt/hours at an estimated maximum output of 15 to 16 million kilowatts. In other words, because the FY 1985 electricity sales volume (estimate based on actual records) was 44.5 billion kilowatt/hours with maximum output of 9.24 million kilowatts, it will be at the rate of about 1.8 fold increase.

The optimal makeup of the source of power (by volume of electricity generated) for about the year 2000 would be hydro and geothermal, 10 percent; nuclear, 45 to 50 percent; coal, 20 percent; gases, 15 percent; and oil, 5 to 10 percent.

Under currently programmed electricity source development project construction, the above can be accomplished and the implementation will proceed with an eye on demand and cost. Naturally, emphasis will be placed on nuclear energy and the fairly well assured accessability to coal burning thermal power in the makeup of electricity generating source. But a weather eye will be kept cocked on any requirement for diversity of fuels, and to technological developments to advance its overall developmental program. The electricity source development construction for FY 1986 includes all of the following on a continuous basis: In the nuclear sector, Genkai Nos 3 and 4 (output 1.18 million kilowatts each, scheduled to come on line in FY 1993 and FY 1995, respectively); hydro, (Tenzan) Nos 1 and 2 (300,000 kilowatts each, to come on line in FY 1986 and FY 1987, respectively); thermal, Matsuura Nos 1

and 2 (coal burners, 700,000 kilowatts each, on line in FY 1989, and after FY 1996), Shinoita Nos 1 and 2 series (gas, 690,000 kilowatts and 870,000 kilowatts, respectively; on line FY 1991 and FY 1995 respectively), Reihoku Nos 1 and 2 (coal, 700,000 kilowatts each, FY 1991 and FY 1992, respectively). As a result of the scale of construction work, the make up of electricity source (volume of generated electricity) in 10 years, or in FY 1995, will be nuclear 47 percent, coal 13 percent, gas 24 percent, which will be closing in on the targeted optimal makeup for the year 2000.

Fast Breeder Reactor (FBR) Acquisition Programmed for 21st Century

When the above described electricity source development program is completed a new electric power source development program to meet the requirements for the 21st century will have to be implemented. For the decade from 2001 to 2010 the development of three nuclear powered and two coal burning thermal generators have been programmed. For economical use of uranium and for efficient operation, improved light water reactors that are under technological development currently are scheduled to be used in the three programmed nuclear powered generators.

However, with a view to promote use of purely domestically produced materials, the practical application of fast breeder reactors (FBR) using plutonium is being considered for this super long range program. Implementation will take place well after entrance into the 21st century; it is worth noting, however, that a jump into acquisition of FBR for the next generation is already being clearly contemplated.

As you are already aware, the FBR is capable of converting uranium 238 into plutonium 239 while in the process of producing electricity. Although uranium 238 that composes 99.3 of all uranium cannot be used as nuclear fuel. The FBR converts uranium 238 into more plutonium 239 than the fuel that is consumed in the process and thus regenerates nuclear fuel as source material. As a result of this process, uranium fuel can be increased 60-fold compared to the light water reactors of the past. Currently, the Power Reactor, Nuclear Fuel Development Corporation of Japan having developed the experimental reactor "Joyo" and the prototype reactor "Monju," research into practical applications are being conducted. In any event, it is being assumed that in the 21st century, this FBR and the new type converter (ATR) will become the mainstay of atomic power reactors. The company is aiming toward practical application and installation will take place in the 2020 to 2030 decade.

While planning for atomic energy powered electricity generation for the 21st century, work is proceeding on establishing an atomic fuel cycle and toward an assured supply of the fuel. The aim is to enhance the stability of atomic energy supplies and to achieve assurance of the atomic energy cycle that is essential to the effective utilization of plutonium. It is essential that there be a standardized national policy independently established by Japan to apply to the reuse and disposition of the waste material from the enrichment and molding process. Structural changes in electric power consumption will be brought about by the increased proportion of atomic energy facilities. To cope with widening variations in the rates of daytime and nighttime consumption, and variations by seasons, operational control systems will have

to be installed to smooth out the peaks and troughs. Considerations will have to be given for the achievement of even a higher rate of reliability and safety, while looking to lower the cost through design improvements and the incorporation of new technologies and materials.

Look to Practicalization and Installation of Gasification of Coal and Multiple Sources of Fuels in Thermal Sector

In the coming 10 years electricity source development will enable the production of a total output of about 7.46 million kilowatts including nuclear, hydro, and thermal systems. Of these, 4.44 million kilowatts output or about 60 percent, will be thermal based. The emphasis in thermal powered generator development will continue even after the year 2000 because due to expanded availability of some types of coal, its ease of transportation and enhanced effectiveness, the aim is to "gasify the coal for multisourced generator fuel" with the practical application and installations of high performance gas turbines. With regard to existing oil burning generators, efforts are being made to lengthen the life of the fuel by continuing suitable residual fuel utilization procedures. In spite of such measures to increase the efficiency of oil burners, this replacement in the electricity generating structure is also being studied.

In the area of provision of fuel supplies, the first plan is to build a petroleum reserves storage structure and an oil procurement program to serve in an emergency of a sudden and large-scale outage of generator facilities. In the LNG [liquefied natural gas] area, efforts are being made to revise the terms of contracts to preclude supplier risks and to offer more accommodations and elasticity. Foreseeing the eventuality of an era of large-scale coal consumption, a resilient structure will be erected, and at the same time, cooperative coal reserves storage will be built.

Outlook of Technology Development Strategy

The demand for a higher level of technology development will undoubtedly become greater in the future. It will be so in the electrical industry, too. Technologies pertaining to new energies, new electricity generating technologies, electronics application and expansion of electricity utilization will all become subjects of major importance.

In an environment such as that, it is essential that the company establish an image of "Technological Kyuden [Kyushu Electric Power Company]." It is important that while working to assure stable supplies of varied forms of energy, it gives consideration to enhancing the quality of its delivery systems, its operations by lowering costs, and even aim for raising the social level.

With the 21st century in mind, the factors that the company is focusing on in its new energy, new power generating technologies are: (1) Improved light water reactors; (2) Fast breeder reactors (FBR); (3) Gasified coal compound generation; (4) fuel batteries.

With regard to improving the light water reactors, the aim is to improve the existing models, greatly enlarge the capacity (1.3 million kilowatt class), enhance work rate (target, 90 percent); economy of uranium consumption (to about 20 percent less). Enhancement of the reliability and safety factors is also targeted. Cooperative research with tool and instrument makers is an ongoing project. The projects are programmed for implementation within this century, and to become operational at the beginning of the 21st century.

The Sunshine Project is central to the research and development program for gasified coal compound electricity generation. Research with a pilot plant is scheduled for about a 7-year period from 1986 followed by actual prototype tests. There is much work being done in expanding the use of appropriate types of coal, and the development of high performance, large gasification furnaces and gas refining equipment. These will be coordinated and should be ready for practical implementation by the beginning of the 21st century.

As for fuel batteries, because the phosphoric acid models are suited for decentralized small-scale facilities, they have been earmarked in the future for electricity source facilities on off-shore islands. Because they have been given longer life and enhanced effectiveness, and because plants can now be constructed at low cost, practical implementation of these should take place within this century.

Because of the high (650 to 1,000 degrees Celsius) working temperatures of the liquefied carbonate batteries and the solid electrolytic batteries, research is currently underway to develop suitable materials. As a fuel, gasified coal can be used and is suitable for the gasified coal composite electricity generation system referred to earlier, so practical application is expected early in the 21st century.

Other projects that are under study from the standpoint of technology and economics and which are earmarked for practical implementation in the 21st century include new types of batteries capable of high performance electric power storage systems; solar and wind powered generation of electricity to supplement the conventional fuels used for offshore islands power generators.

Technological development projects are too numerous to count; undertaking such projects tend to expand the field of applied electronics technology and to the expansion of the utilization base for electricity. In the area of applied electronics technology, construction work and safety related robotics and technologies pertaining to stabilization of online systems, digital technologies come to mind. Practical implementation of these are aimed for early in the 21st century.

In the area of broader utilization of electricity, the heat pump application technology and technologies pertaining to electrical heating by distant infrared rays are being studied. Both are expected to become practical during this century.

Naturally, the projected reenforcement of the company's technology development structure is being doubly reenforced. The first step in this direction is to build up and reorganize the data base for the enhancement of technology

developmental structures for the related technologies. While strengthening the capability of the technological information center, it should double as an analytical technology center, and be used as an on-the-job research and development training center for the younger personnel.

In the future, technological development projects will be focused on the cutting edge of raw materials technology, electronics technology and biotechnologies. The emphasis of these studies will be in areas beyond the current educational limits. The broad-scale intermingling of all research organs, both domestic and foreign, in both basic and applied research fields is essential. To achieve the capability for independent technology development, the nurturing of manpower possessing a broad vision is essential.

The above introduces the reader to the outlook for the 21st century as described in Part 4 of the company's "Scenario for Long Range Operations Programs." That the company's plans embody many projects can be seen by the following points that were also outlined in Part 4: (1) structuring a high level system; (2) aggressively promote the upgrading of the region; (3) establish an image of reliability through public relations and service related activities; (4) display coordinated viable policy to meet changes in the labor environment; (6) aim for coordinated high performance organizational, personnel, and company related policies; (7) develop facilities investment strategies.

The company has given direction to its operations policy for the future through its compilation of the "Long Range Operations Program." Of utmost importance now is that based on the provisions of this paper and tempered by environmental changes, it proceeds to convert them into actual manifestations.

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# ESTABLISHMENT OF FINE CERAMICS CENTER DESCRIBED

Tokyo KOGYO ZAIRYO in Japanese Mar 86 pp 1-13

[Interview with Kazuo Iwata, chairman of the Japan Fine Ceramics Center, and with Tomoyuki Nakano, managing director of the center, by Akira Suzuki]

[Excerpts] Why the Japan Fine Ceramics Center (JFCC) Was Established in Nagoya

Iwata: As you also may understand, Mr Suzuki, I believe technological innovations will play a leading role in influencing the destiny of a state in the period from the late 20th century to the early 21st century. In our efforts to promote those innovations, I believe the innovations in microelectronics technologies are the most important, followed by the innovations in biotechnologies. The Ministry of International Trade and Industry also shares this view.

In these two fields of technology, research has already been underway for some time in the past in the country. In which directions the research develops, or what kinds of results it brings about in the future will depend on the ways of pushing ahead with the research in the coming years. Having come onto the scene following microelectronics and biotechnology are the so-called new materials. Fine ceramics or high-performance ceramics is one of those new industrial materials, and we have given attention to ceramics.

As for why the Japan Fine Ceramics Center (JFCC) was based in Nagoya.... Well, as you know, the Seto and Tokoname areas in Aichi Prefecture have long been the center of the nation's traditional ceramic industry. I don't know exactly when the ceramic industry in the prefecture came into being, but I know that Seto and Tokoname each is included among the names of eight places which have the oldest history of ceramic industry in the nation. The existence of Seto and Tokoname means that Aichi Prefecture has two such centers of ceramic industry within the boundaries of a single prefecture.

There are no direct connections between fine ceramics as a new industrial material and the traditional ceramic industry in Aichi Prefecture. But there is no denying that there are many, many companies in the regions of Seto and Tokoname which are interested in fine ceramics as a commodity in which

they can do business. Concerning the raising of funds for the establishment of the JFCC, we intend to seek the cooperation of people and business companies in various fields. We believe it would be natural for us to seek financial cooperation from those companies related to the ceramic business from across the country in our efforts to raise the funds. Considering the fact that Aichi Prefecture is a major center of the ceramic business in the nation with two major ceramics-producing regions of Seto and Tokoname located there, we reached a consensus that the funds must be sought from the business firms in the regions centering on Nagoya City, Aichi Prefecture and the neighboring Mie and Gifu prefectures. This means, in effect, that the business circles in Aichi Prefecture would be asked to take major shares in raising funds for the establishment of the JFCC. I am glad to say that besides those business circles, the local governments in Nagoya City and Aichi Prefecture have expressed their willingness to extend their cooperation to the establishment of the JFCC.

In the first round of our efforts to raise funds, we aim at collecting ¥8 billion, mostly from business organizations in the Chubu district where Aichi and Mie as well as Gifu prefectures are located. But we want cooperation from other regions across the country, from people and business organizations not only in the Kanto and Kansai regions, but also in Hokkaido, Shikoku and Kyushu islands. As a person to supervise the fund-raising efforts, three candidates were picked from the business world. One of them was Mr Gaishi Hiraiwa, board chairman of Tokyo Electric Power Co., Inc., who, coming from Aichi Prefecture, is an influential figures in the country's business world. The second person picked was Mr Akio Morita, board chairman of Sony Corp. The third person was me. But at present, Mr Hiraiwa is too busy to additionally take the task of raising funds for the establishment of the JFCC, because he is now preoccupied with the jobs related to public works projects. Mr Morita is also too busy tackling the business related to measures to alleviate Japan's trade frictions with the United States. Under these circumstances, I was picked as the most suitable candidate to oversee the fund-raising efforts on the grounds that I, as an adviser to Toshiba Corp., am an influential figure in the nation's business world, and at present, I have no pressing tasks at hand which call for urgent attention. Considering the prospect that the establishment of the JFCC would contribute to the prosperity of Nagoya City and for other relevant reasons, after I was asked to take charge of the fund raising, I finally agreed to do the job, and also to assume the chairmanship of the JFCC after its establishment. Those other reasons concern the fact that our company, Toshiba Corp., is at present engaged in research and development activities involving high-performance ceramics, and that Toshiba has a subsidiary, Toshiba Ceramics Co., Ltd. As for the so-called new industrial materials, Toshiba has a corporate division engaged in research and development on metal materials. With myself now having agreed to serve as the first chairman of the JFCC, I want to have an honorary chairman who will assist me in operating the fine ceramic center. I personally want Yoshihiro Inayama, chairman of the Federation of Economic Organizations (Keidanren), to accept the honorary post.

How JFCC Is Proceeding Toward a Center Concept

Iwata: As for the question of what is fine ceramics, at present there are no established definitions either from an academic or experimental point of view. Even though there is no established definition, we have agreed that in order to push ahead with technological innovations, we must secure researchers to engage in research activities dealing with high-performance ceramics. Of course, we admit that securing financial assistance for the operation of the JFCC is also important. However, in consideration of the importance of securing able researchers, we decided to ask the Toyota Motor Corp. to play the central role in our efforts to recruit the researchers. I personally believe that picking Toyota Motors for the company's cooperation was a wise decision.

Mr Eiji Toyoda, chairman of the car manufacturing company, is vice chairman of the Keidanren. He is not serving the Keidanren post as a representative of the business world in Nagoya, but is serving as a man representing the business community of the country. However, it can be said that Toyota Motors is the most prominent entity in the business community in Nagoya in respect of both the psychological assurance the company gives the community and in the size of human resources it maintains. These reasons have led us to persuade the vehicle manufacturing company to consent to play a major role in the management of the JFCC. In asking Mr Toyoda for his company's cooperation, we told him of our wish that his company would play a major role in the operation of the JFCC. As the chief managing director of the JFCC who is directly responsible for running the fine ceramics center, Mr Masatoshi Morita, former vice president of Toyota Motor Corp. who is currently an adviser to the company, has accepted the JFCC post.

The problems we are facing at present are how to secure competent people to engage in research and development of fine ceramics, a new and unexplored field of industrial materials, and what research targets should be assigned to them. Concerning these problems, I would like Mr Tomoyuki Nakano, a managing director of the JFCC, who is also present at this interview, to explain later in this interview.

Referring to those human resources needed in running the JFCC, we have managed to secure only a few people from external organizations so far. In addition to the difficulties we have been experiencing in recruiting able engineers, we have yet to decide what research targets to assign to those recruited researchers.

The only thing we have decided with regard to setting up the JFCC so far is to equip the fine ceramic research center with the latest, most advanced research and testing equipment needed to pursue the research goals of the center. The necessity for first-class research equipment could be likened to a situation in conducting research on aircraft in which it is indispensable

for the researchers to secure a wind-tunnel testing facility which costs a huge sum of money. In Japan, such a wind tunnel is owned by the Science and Technology Agency's National Aerospace Laboratory in Tokyo. The wind tunnel has been used not only by governmental research institutions, but also by external private-sector research organizations. Just as in the operation of the government wind tunnel facility, we aim at making the JFCC to be set up in Nagoya into a nucleus facility in the nation in the research of high-performance ceramics. At present, we are making preparations to introduce the latest state-of-the-art facilities necessary for research on fine ceramics into the Nagoya center.

Then, we are still studying what types or kinds of equipment should be introduced into the center. An unduly long delay in deciding on the types of equipment to be introduced is not warranted. But we are having difficulties in recruiting researchers, and the construction of JFCC buildings will not come until next year. Under these circumstances, we would like to take enough time to decide what types of equipment should be introduced into the center--for example, what types of computers should be bought and what types of researchers should be recruited--by consulting various people concerned. In connection with our preparation for the establishment of the JFCC, the chief editor of KOGYO ZAIRYO, a magazine which NIKKAN KOGYO SHIMBUN publishes, has shown interest. If you also have interest in our project as an innovative person, Mr Suzuki, I would like you to take time to discuss the matters concerned with our people, centering on Mr Masatoshi Morita, the chief managing director of the Nagoya fine ceramics center.

My responsibility as chairman of the center is to try to secure funds needed to set up and operate the JFCC. There may be a shortage of funds from ¥100 million to ¥200 million finally, but at present I'm confident that I can manage to raise funds very close to the targeted sum. As regards the assistance to be extended by the municipal government of Nagoya City and the government of Aichi Prefecture, their assistance will not necessarily take the form of cash contributions. There is a possibility that they will extend their cooperation to the foundation of the JFCC by leasing the land plots necessary for the construction of JFCC facilities. Or there is also a possibility that those local governments will ultimately sell those leased land plots to the center after some years of leasing. But financially, it can be said that the fundamental base of the Nagoya Ceramics Research Center has already been established. So far, in my opinion, everything has proceeded as we originally planned with relative ease generally in our preparations to lay the foundation for the establishment of the center. After having almost completed laying the foundation, the major problem we are facing now is what concrete steps we are going to take in the coming months toward the establishment of the JFCC.

If you want to hear more about that problem from the people concerned with the establishment of the JFCC, Mr Suzuki, I would recommend that you go to Nagoya and talk with them, including Mr Morita, the chief managing director of the center. I believe that at present Mr Morita may also be trying to shape up his own ideas concerning the further steps to be taken toward the start of

operation of the fine ceramics center. At present, we are unable to foresee what kinds of new industrial materials will appear in the future, and I presume, Mr Suzuki, that you know better than I the difficulty of forecasting the future developments in respect of new industrial materials. If you want to have further talks on this question in Tokyo, I would recommend you visit our company and call on a managing director. His name is Ando, and he is in charge of the problems which include the future developments in the field of new industrial materials.

Suzuki: Well, to tell the truth, I had the honor of interviewing Mr Ando before, as the eighth top corporate figure to be introduced in this column of KOGYO ZAIRYO. The interview appeared in the December 1984 issue of that magazine. In fact, his views on ceramics were highly enlightening to me.

Iwata: Mr Ando is indeed a specialist on that matter, and he should have met you today for this interview instead of me. On the technical matters concerning ceramics, I'm rather his deputy, although I have been chosen to head the Nagoya fine ceramics center. I have long been in charge of financial matters at the companies for which I have worked, and now I'm again responsible for financial matters at the JFCC. Due to this background of my career, I'm afraid that I am not the right person to discuss the matters related to ceramics which might be of prime interest to you. (laughter)

Standpoint Roles and JFCC Chairman

Suzuki: In this series of interviews with top leaders of the nation's business community, I have met 20 leading figures so far. In fact, through these interviews, I have had many talks on various topics on technology with a number of them. Those topics included ceramics, metals and high molecular compounds as industrial materials. So, in this interview I am posing questions to you, Mr Iwata, expecting that today I will be able to hear the views and perspectives you may have concerning the matters related to ceramics and other new industrial materials as the head of the JFCC, from a high vantage point...

Iwata: Well, you say that you want to hear the views and perspectives I have from a high vantage position as the chief of the JFCC, but as I said a while ago, my speciality is financial matters.... The other day recently..., well, if my memory is correct, it was at a certain governmental committee meeting that.... The panelists present at the committee meeting said electronics would play the central roles in Japan's high-tech industry in the future. I believe this is true. They said biotechnology would come next in importance as the driving factors of high-tech development in the nation. But in my opinion, biotechnology is the field where people concerned must exercise their utmost caution. The biotechnology field is where particularly appropriate guidance must be given by the authorities. This is because the questions of biotechnology involve not only problems of technology, but also of ethics. The specialists at the governmental committee pointed out that the matter related to the new industrial materials as the third most important issue. I have a friend who is in the iron business. In connection with remarks on the new industrial materials which came up at the governmental committee meeting, I jokingly said to him recently that in the future iron may come to be used no longer.(laughter)

Suzuki: Well, to tell the truth, Kenzo Toda, vice president of Nippon Steel Corp., voiced similar apprehension when I met him for an interview as the 19th top management figure to be introduced in this column. The article featuring Toda was carried in the December 1985 issue of KOGYO ZAIRYO. But Mr Toda said that he is confident iron will continue to be used as an industrial material forever in the future.

Iwata: At present, I serve on many government committees as a member, and I have been busy attending those committee meetings when they hold gatherings. Due to the many committees and the frequency of attending their meetings, it is difficult for me to keep track of who said what at which meeting. But in general, many members of those government committees on technological matters believe that reinforced plastics will play an increasingly important role as a new industrial material in the future. I personally believe that iron will continue to be used. But at a government committee meeting held some time ago, there was a member who said that when glass-fiber-reinforced plastic and carbon-fiber reinforced plastic begins to be used commercially, steel makers in the world will stop building new steel manufacturing plants to maintain or boost production.

In connection with this remark, I pointed out to him that iron rusts and finally decomposes and disappears, but plastics do not, posing a problem. And I remember that I posed a question about the methods of disposing plastics at a meeting of a certain scientific gathering. I pointed out that plastics, which do not decompose, cannot be dumped in the garbage like other kinds of wastes which decompose and in time disappear. I also posed a rather amateurish question at the meeting by saying that if the fiber-reinforced plastics come into commercial use, it could be anticipated that the land not only of Japan, but also the world would be littered with plastic products all over them in the future. In fact, Mr Suzuki, I have an impression that those so-called new materials are extraordinary things.

And it is those materials which have been dreamed of by many scientists so far. As one who majored in law at the university and knows little about technical matters, it would be rather amusing for you, Mr Suzuki, to hear me saying something like this, but I learned that scientists envisage creating new alloys under weightless conditions by building factories in space. I do not know what kind of alloys could be developed under such conditions. When I began referring to topics like those technical matters in our conversations with..., he tended to tease me often. (laughter) (According to this interviewer's conjecture, Mr Iwata seems to be referring to Managing Director Ando at his company with a tone of friendliness toward him in making this remark.)

Due to those various reasons I have mentioned so far, I'm afraid I could not give you what may be of interest to you on the subject of fine ceramics in this interview, Mr Suzuki. Mr Ando has charge of the technical matters on the high-performance ceramics at our company. He is really a specialist on the technical matters. However, on the matters of money, he is totally an amateur. (laughter) This is why I must devote myself to the affairs related to finance.

Suzuki: Well, I didn't plan to ask a question like this in this interview with you, Mr Iwata, but.... Since I graduated from school, I have long been engaged in research and development in the field of chemistry. My question concerns how much a man who is related to research and development activities at a corporation or other institution is required to be interested in monetary affairs in proceeding with their activities. Personally, I am apprehensive that a researcher's paying excessive attention to financial matters would detract from his activities as a researcher, due to the possibility that paying excessive attention to the question of financial viability could prevent him from making an adventure in his research.

Iwata: That is an issue in which it is difficult to give a clear-cut answer. I would say that your observation on that matter may have a point in certain cases, but not always. This would be a little off the very topic we are discussing, but there is a marked difference in the way of advancing research on high technologies between profit-seeking private institutions and governmental institutions.

Research at state institutions lacks incentive for the researchers. In contrast, researchers at private companies and research institutions have the incentive to encourage their research. How properly to manage those incentives, I think, is a problem with which the authorities and those private entities have to deal.

In many cases, you cannot expect many innovations you would welcome from those business firms which are making good profits. Such firms tend to be crafty in their way of doing business. They invest plenty of money in the field of applications, but use little money to promote the innovations of technology. In general, this practice is the one which the United States has cited often in criticizing Japan in arguing against a matter involving high technology. A similar attitude like that of the United States against Japan is being taken here in Japan by large corporations against smaller competitor companies which are making good profits. The people in large companies, like ours, vent their dissatisfaction on their smaller competitors by calling them unfair in their business practice.

To deal with this problem, I believe there are no effective countermeasures which those who are dissatisfied can take publicly. Due to this, it is very difficult for me to give a satisfactory answer at this juncture to your question, Mr Suzuki.

Necessity for Incentives

Suzuki: Now changing our subject a little, about 2 weeks ago, I had a discussion in a forum with the participation of three people from three government research institutions with myself acting as the moderator. The discussion was held as part of this series of interviews, and the article on the discussion was carried in the January 1986 issue of KOGYO ZAIRYO. The participants were two heads of research institutes from the Science and Technology Agency's National Research Institute for Metals and the agency's

National Institute for Research in Inorganic Materials based in Tsukuba, Ibaraki Prefecture, and another chief from a research center of the Ministry of International Trade and Industry's Agency of Industrial Science and Technology. The MITI man was from the Fiber and High Molecular Material Research Institute. The discussion was conducted on topics ranging from metals, inorganic substances and high molecular substances as industrial materials, compound materials to be made by combining those materials, to the prospect of developments of those materials in the 1990's. We received favorable responses from the readers of KOGYO ZAIRYO for the usefulness they found in the contents of the discussion article.

Iwata: I can see how such a program was useful and proved interesting to many people. Today, electronics is regarded as the centerpiece of high technology. But it is an undeniable fact that chemistry is playing no less an important role in the high-tech fields. To tell the truth, our company does not have many chemical researchers. This is because our company is a machinery maker. Until some years ago, a machinery company needed new chemists. About 50 years ago when I joined Toshiba Corp., the jobs which were assigned to many of the Chemistry Department graduates of the University of Tokyo after they were employed by business firms were those related to analysis. They were obliged to engage in tedious work analyzing things at the research institutes and centers of those companies throughout the day every day. They were not assigned jobs which called for them to be chemical specialists.

Suzuki: I also majored in chemistry at the University of Tokyo's Department of Science. Two of my acquaintances who graduated from the same state-run university 1 or 2 years earlier than I, respectively, joined your company. I hear that they did good jobs in research on fluorescent materials to be used in making fluorescent lamps, which Toshiba was then developing.

Iwata: I hear that today chemistry is playing an increasingly important role. To tell the truth, I have little knowledge about things related to chemistry. But the president of our company, who is an engineer, says that today the responsibility of chemists has increased greatly.

Until some years ago, chemists were in general slighted for the jobs they were doing, analyzing things. I'm sorry for saying this, which may sound like an insult to chemists, but it is true that in the old days people did not show respect for chemists. But the importance of chemists and people's way of treating them has changed with time.

Suzuki: I notice the topics of our conversation have shifted to matters of chemistry. One thing I would like to point out by taking advantage of this is that we chemists think neither electronics, machinery nor physics has the power to transform an object into a different substance. But chemistry has the power they lack. With this perception, many chemists encourage those young people who are studying hard aiming at entering the university to study chemistry when they are successfully admitted to universities by telling them that from now on chemistry will be the most interesting subject to take up. (laughter)

Iwata: Do you think biotechnology is also included in the category of chemistry?

Suzuki: Yes. Today, I think chemistry is playing an important role.

Iwata: I also serve as an adviser to Japan Tobacco Inc., which was known until recent years as Japan Tobacco and Salt Public Corp. These days, the sales of tobacco are beginning to slow down because people have begun to seriously consider their health after the harm done by smoking has been pointed out increasingly in recent years. The corporation has many agricultural scientists and chemists with doctorate degrees engaged in growing tobacco.

Now with the former government corporation privatized, the importance of the roles played by the privatized corporation's research institute where those scientists and chemists are working has increased greatly. Management at the corporation is racking its brains over how to promote innovations in the nation's tobacco industry. To promote those innovations, Mr Minoru Nagaoka, president of Japan Tobacco Inc., places high hope on the research institute. Until some time ago, the institute was a government research organization, and it had more than enough researchers working there. Due to this, even after it was denationalized, the research institute continues to keep too many researchers. The other day when I met Mr Nagaoka, he told me he was considering making use of those rich human resources in the field of biotechnology. In fact, Mr Nagaoka said he was already exploring the possible fields in biotechnology where his corporation can use those human resources effectively.

Suzuki: Hearing about Mr Nagaoka's intention to venture into the business of biotechnology using his company's abundant human resources, I think he must now seriously consider the incentives you referred to earlier in this article for those researchers. As regards the incentives for researchers, many state research institutions have lacked them. But the situation has changed of late and many government research institutions have begun to introduce various kinds of incentives recently. I found this kind of change occurring through the discussion with the three heads of government research laboratories of the Science and Technology Agency and the Ministry of International Trade and Industry, as referred to earlier in this article. I also ascertained this change occurring by myself visiting a number of government research institutions in the past. I believe this change has been prompted, for one thing, by the fact that private-sector companies are generally quick to put into commercial application what those researchers at the state laboratories devised or invented. Another possible reason behind the change is believed to be the perception on the part of those national research institutions that unless they try hard in their research activities, they could be left behind by their private-sector counterparts. There is a good possibility of this situation occurring, because in general the progress of research is faster in private sector research institutions than in state laboratories.

Iwata: That is a welcome situation. The problem concerning researcher incentives is an issue which also has something to do with the government's efforts to carry out an administrative reform. At state-run research institutions, there is no flexibility with regard to the size of the research budget and other monetary matters related to research activities. In taking a business trip, the travel expenses are also controlled rigidly. I think such a lack of flexibility and the rigidity is limiting the research activities of researchers at those state research institutions. At present, a deregulation of the regulations concerning the behavior of public service employees is under deliberation in a government committee. As a member of the committee, I argued at a committee meeting that good results could not come out of the research activities at those state research institutions as long as the researchers continue to be bound by those rigid regulations. For example, the regulations prohibit researchers at those state-run institutions from going out of their institution buildings without due reason during office hours.

To promote good results in trying to invent something, it is necessary for a researcher to devote himself fully to his research when an idea hits him. When such an idea occurs to him, he is required if necessary to continue to work all through the night. When he has difficulty thinking out a good idea, there could be time for him to spend in front of a television set watching a baseball game for relaxation. After this refreshment, he can return to his laboratory to resume his research. These flexibilities have to be allowed researchers. These flexibilities are needed, of course, but it would be embarrassing to the higher-ups if there was a researcher who is always watching TV and failing to do his research earnestly on the pretext that he needs relaxation. (laughter)

At the discussions which have been conducted on issues related to an administrative reform, questions concerning those researcher incentives and flexibilities have been taken up frequently. In such a discussion, progress tended to slow down once the issue moves to matters of public-sector workers. The researchers at the state-run research institutions are public service employees. It is true that the highly rigid public service regulations have been posing as one of major obstacles which have prevented the revitalization of the research and development activities in Japanese research institutions.

Suzuki: I agree with you on that point. In fact, a large sum of the taxpayers' money is allocated to those state-run research institutions. But efficiency at those institutions has been low due to the reasons pointed out so far.

Iwata: Yes, efficiency is surely low. What we are discussing at our committees is how to realize the needed deregulation.

Suzuki: State-run university professors are also public service employees. But they are enjoying a larger degree of freedom compared with the researchers at state-run institutions as a result of some degree of deregulation which

has been implemented under relevant special laws. But the situation is different for those researchers at the state-run institutions for whom the provisions in the special laws are not applicable. As you pointed out a while ago, Mr Iwata, I also have the same opinion as you in that unless they are given more freedom in their activities at their institutions, we could not expect good results from their research.

Iwata: But despite the larger freedom, state-run university professors also express dissatisfaction. A professor from the University of Tokyo who always sits next to me (at the committee meeting) pointed out the other day that unlike those researchers at the governmental research institutions, university professors must give lectures to students. He complained of the situation for university professors who must teach and do research saying that they cannot devote themselves to research like those at the state-run research facilities because they must interrupt their research to teach students despite their reluctance to do so.

Suzuki: But at the University of Tokyo, there is a special category of professorship for those attached to the university's Institute of Industrial Science, which, by exempting them from teaching class, allows them to devote themselves to research. But I wonder about the effectiveness of such a system with regard to increasing the efficiency of their research. My belief is that they would do better to be involved in brisk exchanges with their students and, at times, would necessarily be stimulated from the outside world. Of course, such a system would permit those professors to devote themselves fully to their research. But I think their exchanges with their students might sometimes bring a fresh new idea to them, although the suggestions from those students may sometimes be of a drastic nature.

Appropriate Case-by-Case Deregulation of Researchers

Iwata: Permit me to go off our main topic for a while. Taking golf for example.... I see a number of professional golfers have written books to teach the novice how to play. But in my opinion, what they say in their books is nonsense. What they say regarding the playing techniques of golf in their books does not take into consideration the physical condition of elderly people. (laughter) That is true. I would say it is impossible for everyone to do just what those professional golfers recommend in their books. This is because, for a man of 75, the bones have become brittle and he would be unable to move his feet freely. At such an advanced age, he would be unsteady, too, in his movements.

By taking this difference of physical conditions into account, when writing a book, a professional golfer should refer also to the recommended ways of playing golf for an elderly novice of, for example, 75 or so. I would say that the practice of those professional golfers recommending only a single, uniform method of playing golf, as they do in their books, is unacceptable.

The recommendations contained in those books are made by those professional golfers who are, in general, still young, and not taking into account the frail physical conditions of the aged. Many beginners are buying such books written by those professionals to learn how to play golf. And there may be some people who would willingly pay tuition fees as high as ¥500,000 to ¥600,000 to a professional golfer to learn how to play golf by receiving personal instructions from him, but they don't make any appreciable progress in their learning. In my opinion, it is only natural that those novices do not make progress because their teacher is in a different physical condition compared to theirs. (laughter)

The same can be said of effecting a deregulation for the country's research institutions. Before going ahead with the deregulation, we must consider what the situation at private-sector institutions should be, what business university professors should be required to do and how the researchers at state-run research institutions as public service employees should behave and what working environment they should have. Those people working in different working environments have their own customs and ways of doing business which are different from those working in other environments. Consequently, when carrying out a deregulation, it must be implemented by taking into account those different factors. Carrying out a uniform deregulation by disregarding those differences between private- and public-sector employees could lead to a condition tantamount to nonintervention. I have been pointing out the importance of taking those things into consideration to the government (through my arguments at the meetings of government committees).

Suzuki: As regards the ability of those researchers at the state-run research institutions, there is a wide gap between excellent ones and not so excellent researchers. In general, the activities of those top-notch researchers tend to be bound rigidly by the regulations. One of those top-grade researchers is Mr Makoto Kikuchi. I believe if the deregulation is to be carried out appropriately, as you suggested, more researchers as excellent as Mr Kikuchi would appear in the future.

Iwata: Mr Kikuchi is the head of Sony Corp.'s Central Research Laboratory, isn't he?

Suzuki: Yes.

Iwata: I am interested in what he said.

Suzuki: He is a very competent researcher. He has been doing excellent work ever since he was working at the electrical testing laboratory, the predecessor of the Electrotechnical Laboratory of the Agency of Industrial Science and Technology in Tsukuba in Ibaraki Prefecture.

Iwata: Reading his reports and other materials, I found that Mr Kikuchi writes so even ordinary laymen can easily understand the content. For me, he is an interesting figure.

Suzuki: Mr Kikuchi is indeed an excellent researcher. He has demonstrated that even at the state-run research institutions, an excellent researcher like him can be nurtured. In view of this, it is necessary for the authorities to push ahead deregulation further at those government research institutions. When such a deregulation is implemented, those researchers at the state institutions, positioned a notch lower than Mr Kikuchi in their competence could possibly do better jobs in their research work.

Recently, exchanges between Japanese researchers and their foreign counterparts have been on the increase. Once a researcher at a national research institution in Japan has released a report on a major achievement in his research, requests pour in from various research organizations abroad asking him to travel to their countries and lecture at their institutions almost immediately after the publication of his report. In many cases, those foreign establishments which request him to travel and lecture at their institutions are willing to shoulder no more than half of his travel expenses. In such a case, the institution to which he belongs is also reluctant to pay the rest. To add to this problem, the national research institutions in Japan do not permit their researchers to travel on official business often. Under these circumstances, some researchers who receive such a request to travel and lecture are forced to do so by obtaining a leave of absence from their institution.

Iwata: If a researcher must secure a leave of absence from his institution for such a purpose, he is inconvenienced and experiences various problems.

Suzuki: For these reasons, he is forced to make the trip on private business in the end. Considering these difficulties experienced by the able researchers in Japan, I sense a necessity for more incentives in such matters for those researchers. And as I said a while ago, once a researcher at a government research institution achieves a feat in his research, private sector business companies take notice of him and he soon becomes the target of so-called headhunting by those companies.

Iwata: Once he has been hired by a private-sector firm, he tends to be given far better treatment than he received at his former state research institution immediately after he begins working for the firm, even though he is not given an executive post itself. The work corporate executives do is mostly commonplace. (laughter) So a competent man who has been headhunted from a national institution would be given the treatment of an executive, but not given an executive post itself, so that he can do various jobs. In fact, such a man is made to do various kinds of jobs after he has been hired by a private-sector firm.

There are many engineers at our company who are receiving the treatment of executives. Our company permits them to continue to work until they reach 70. Such a long period of employment is part of the benefits which those receiving the treatment of executives enjoy.

Once the Outlook of JFCC's Foundation Is Established, What Is the Definite Future Move?

Iwata: I'm sorry for my inability to discuss subjects related to the Japan Fine Ceramics Center other than matters associated with funds for establishment of the center, but securing the necessary funds is the most important task in the ongoing preparation for the establishment of the JFCC. Initially, we aim to raise ¥8 billion. I think the sum which I have managed to secure so far is close to the targeted figure. With most of that sum having been raised by now, I think I have almost fulfilled my primary duty, and this makes me feel relieved.

With most of the needed funds having been secured, the task we must tackle from now on is the types of research equipment we should buy for the Nagoya fine ceramics center. We hope not to be faced with many difficulties in constructing the JFCC buildings. In addition to the task of choosing the right kinds of research equipment, another problem we are facing is the difficulty in recruiting competent researchers to work at the JFCC. We are prepared to pay high salaries to the right researchers. But the situation is that truly competent researchers who are currently working at other institutions are in general reluctant to quit jobs at their present work places.

Suzuki: By the way, I would like to hear your view on the relationships between the Nagoya ceramics center and the Nagoya Testing Laboratory of Industrial Science and Technology of the Ministry of International Trade and Industry's Agency of Industrial Science and Technology, when the center begins to operate. I would like you to answer this question by taking into account the issues concerning the funds and human resources, which we have discussed so far.

Iwata: There is no relationship between the two Nagoya-based research institutions. This is because they are completely different institutions. So they will operate completely independently of each other. Concerning the question of recruiting researchers for the JFCC, we have approached some young assistant professors at state-run universities. But they have been cautious about leaving their present posts because they are still uncertain about the future of the JFCC.

In connection with the future of the JFCC, I will have our managing director, Mr Tomoyuki Nakano, who is present here, explain to you the outline of the vision which our chief director, Masatoshi Morita, who is directly responsible for running the ceramic center, has in mind.

Suzuki: Then, Mr Nakano, could you explain concretely about the JFCC in terms of the funds needed, human resources the center is recruiting, research activities, etc.?

Nakano: So far in this interview, various issues concerning the JFCC have been discussed between you and Mr Iwata. So I would like my explanation would be supplementary to them.

First, concerning the question of raising funds, we set the target at ¥8 billion. Of this figure, we plan to secure ¥5.9 billion from the nation's business circles. Besides our intention to collect such a large amount of money from the private-sector business world will be our efforts to try to exploit private-sector resources. The projected target of ¥5.9 billion breaks down into ¥3.45 billion from the Chubu region (where Nagoya is located), and ¥2.1 billion from a number of major trade federations. We have a sum of ¥350 million, which we took over from a council for the foundation (of the JFCC). With all of these figures added, it comes to ¥5.9 billion in total.

And as Mr Iwata said a while ago, we believe the ceramics industry in the Seto and Tokoname areas of the Chubu region will become increasingly necessary to introduce fine ceramics technologies in the future. In fact, industry people in these areas put high expectation on the benefits which the establishment of the JFCC will bring to them. Considering those benefits which the JFCC will give to the industry in those areas, we intend to raise the funds to a total of ¥1.6 billion from the local governments in the Chubu region--the municipal government of Nagoya City and the three prefectural governments of Aichi, Gifu and Mie. We intend to raise the rest of the targeted goal of ¥8 billion in funds for the establishment of the JFCC--amounting to ¥500 million--from the government Japan Keirin Association in the form of a subsidy.

At present, as regards the sum of Y3.45 billion which we aim to raise from the business circles in the Chubu region, we have secured readiness for a contribution to the funds from business organizations in the region for the sum of ¥3.2 billion. This means that only ¥200 million more has yet to be raised in the region.

Regarding the sum of ¥2.1 billion which we aim to collect from a number of other major private-sector trade federations, about one-half of the projected sum of monies will come from the five major industrial federations. They are the Bankers Association, the Japan Automobile Manufacturers Association, the Japan Iron and Steel Federation, the Federation of Electric Power Companies and the Japan Communications Equipment Manufacturers Association. We asked these industrial organizations for their contributions to the JFCC funds. Of them, three organizations have already agreed to make cash contributions, and we expect we will hear from two other organizations as to their decisions on the contributions soon. Consequently, I believe we will be able to raise about 50 percent of the sum of ¥2.1 billion from these five major industrial federations. In general, our efforts to collect the funds have been proceeding relatively smoothly.

Now, turning to our efforts to seek contributions from the aforementioned local governments, they are going to put the bills concerning the contributions before their respective assemblies to be held at the end of March for permission. What I have mentioned so far is all I can say at this juncture about our efforts to secure funds for the establishment of the Nagoya ceramic center.

As regards our efforts to recruit researchers for the center, as Mr Iwata told you in your talk with him a while ago, we have had difficulties. We intend to have those recruited researchers engage not only in basic research, but also in applied research based on the results they achieve in basic research, so the JFCC can play the role of a national center in high-performance ceramics research. And we also intend to make the JFCC play a role to combine the research activities of a number of separate research groups, each a joint research group involving the government, industry and academic institutions. We have been making efforts to recruit researchers for the JFCC by explaining to our candidate researchers the nature and mission of the Nagoya fine ceramics center and seeking their understanding of this.

At present, we are recruiting researchers who will form the nucleus of the JFCC's research personnel. As of yesterday, we had recruited three people informally. And one of them has already begun working toward the establishment of the center.

The center building which is now under construction--the construction work started on 22 October 1984--is scheduled for completion in March next year. Immediately after completion the installment of basic research facilities will begin. So we believe that the Nagoya ceramic center could begin functioning as of April next year. This means we must complete recruiting needed researchers by the end of the current fiscal year (ending 31 March next year), and we are now making stepped-up efforts in the recruiting and other preparation work.

Suzuki: How many people do you plan to hire?

Nakano: Again, as Mr Iwata said a while ago, the ultimate number of researchers we will hire will vary widely depending on what research theme we are going to assign to them. I admit I'm not an expert on this matter, but at present we intend to put a larger emphasis on the research of fine ceramics as a structural material rather than as a functional material as a research theme at the JFCC. Considering this plan of going ahead with the research, I think about 40 researchers would be necessary at the initial stage.

Suzuki: In recruiting those researchers, there are two methods which we can adopt. One is to aim at recruiting all the intended number of researchers at one time, and the other is to try to hire researchers whenever competent ones appear without setting a deadline for recruiting all of the intended personnel. Which does your center intend to choose?

Nakano: Hiring only truly competent researchers without being bound by a deadline would be one way of recruiting that is worth consideration. But considering that we intend to make the Nagoya center a research institution which is equipped with the latest research facilities and manned by top-notch researchers, and to make the research at the center open research, we cannot sit still waiting for a competent researcher to appear. Considering such a nature of the center, I feel it necessary that we must continue to make positive efforts to secure at least those researchers who will serve as the nucleus of the center's research personnel.

Suzuki: What do you mean by the term "open research?" Could you elaborate on that concretely?

Nakano: The answer to your question concerns what I mentioned a while ago about the JFCC's mission. In general, the research on high technologies, including research on high-performance ceramics, in Japan is being conducted by a number of separate research groups with some of them being joint research groups involving the government, industry and academic institutions, without much mutual exchange of research-related activities among those groups. The Nagoya center is intended to promote those exchanges by, for example, allowing anyone from those separate research groups to visit the center any time when the necessity arises to exploit research results at the center for the benefit of their research. The term "open" was supposed to mean this. Of course, I admit we would be required to make some adjustments on our part to deal with the "vertical structure" of a research group in the nation in which the group members are aligned vertically with the government sitting at the top, industry positioned below the government and academic institutions coming under industry when the group is a joint research one involving these three parties.

To summarize the purposes of establishing the JFCC, as Mr Iwata said, we intend to make the Nagoya center one where all data and technical information concerning fine ceramics are available, and where anyone can obtain any kind of information at any time irrespective of the limitations resulting from the vertically aligned structure of the nation's research institutions. Considering the purposes of establishing the JFCC, I think the ceramic center should be an institution open to anyone.

Because of this, I think we should be careful that the researchers we are going to hire are not concentrated on a particular region, but should try to recruit them from a wide region covering the entire country.

Suzuki: Then you are planning to make the Nagoya center the nation's center in research on high-performance ceramics....

Nakano: That's right.

Iwata: Next to the land plot where the construction of the JFCC buildings is now underway, there is an attractive apartment complex run by the Nagoya municipal government. This closeness of an apartment complex would allow the researchers working at the ceramic center to live at relatively reasonable cost in such a large city as Nagoya.

Suzuki: In what part of Nagoya is the JFCC located?

Iwata: It is close to the Atsuta Shrine, east of the shrine.

Suzuki: I did not know the JFCC is located in such a good place.

Iwata: In front of the JFCC is a large-scale apartment complex, and because of this the area surrounding the ceramic center is very quiet.

Nakano: It's about 17,000 square meters.

Suzuki: I'm surprised to hear that there still was such a large unused land plot in that area.

Iwata: In fact, there are still more unused land plots around the place. So if we want a still larger land plot than we have secured, it's still possible by buying more land plots. The only reason we do not do so is because we have no money to acquire more land. (laughter) Around the place of our center, there is still unused land about twice as large as the land plot we bought. Some warehouses are standing on this unused land. But it seems those warehouses are no longer in much use. I think those warehouses could be bought (along with the land) any time it is necessary (for us to buy more of this unused land).

However, this does not mean at present I am considering buying more land. Under present circumstances, where we have yet to lay the foundation necessary for the establishment and operation of the JFCC, we could spend no more money for buying additional land. What I meant to say is only that it is still possible for us to expand the land area of the JFCC now, if we so wish.

Suzuki: Referring to the "open" research, as mentioned by Mr Nakano earlier in this interview, does it mean that there would be a possibility that those researchers recruited by the Nagoya ceramics center will work together with those dispatched from the governmental research institutions or universities in a joint research program for a certain period of time after the center begins functioning?

Nakano: I believe it would naturally become necessary for us to allow such a thing.

Iwata: But at present, there are not many researchers who have, even unofficially, been hired by our center.

Nakano: At present, we have three unofficially hired researchers. Yesterday, we employed two researchers informally.

Iwata: One of them is a woman. So I was told. Including her, we have hired only three people so far. The efforts to recruit researchers for the JFCC are now underway. It is only natural that we could have recruited such a small number of researchers so far considering the fact that it was only about 1 week ago that we held a ground-breaking ceremony for the construction of the JFCC buildings. At present, we have virtually nothing for the ceramics center.

Nakano: To make the Nagoya ceramic center an institution open to the outside, we envisage making the center function not only as a place to conduct research, but also as an organization which extends guidance and other necessary assistance to small and medium enterprises. I think conducting full-fledged research on fine ceramics would entail too many costs and burdens for those small and medium companies to bear. For those firms, we intend to extend our assistance in the form of giving technological guidance, technological training to their employees and leasing our equipment. This is one of the purposes of establishing the Nagoya center.

And another purpose is that as a national center, as Mr Iwata referred to a while ago, the JFCC would be required to serve as an organization for promoting communication and other forms of exchange with foreign countries in the field of high-performance ceramics.

Considering these tasks which the JFCC would be required to fulfill, we feel the need to introduce a way of running the Nagoya center which would allow it to carry out those tasks most efficiently.

Suzuki: Does that mean the JFCC will also be equipped with a data base covering all aspects of ceramics technologies in Japan to make it possible for visitors to the center to obtain any kind of data and information about the ceramics they want?

Nakano: Yes.

Iwata: I've also heard about the plan to build the data base. It's true that we intend to create the data base. The plan would call for inputting all kinds of information about ceramics into the computers at the Nagoya center.

Suzuki: The creation of the data base would save those people wanting to obtain some kind of information about ceramics the time-consuming necessity of calling various organizations to....

Iwata: At present, there is no such data base available in the country, but there is a plan to create one at the Nagoya ceramic center.

Nakano: At present, the JFCC is conducting a survey for the government in preparation for the government's plan to create a data base on high-performance ceramics. The government wants the current survey to be completed in about 3 years. Based on the results of the survey, it is believed that the government will take additional concrete action toward building the data base. Naturally, we aim at creating a similar one at the JFCC.

Suzuki: Then are you considering building a data-base system which would allow people to access it from their terminals?

Nakano: Naturally we would be required to consider introducing such a system considering the need in today's date-base service.

Ambitious Plan for JFCC Operating Expenses To Be Self-Supporting

Suzuki: As far as the explanations about the establishment of the JFCC given so far are concerned, I understand that the monetary contributions amounting to some ¥8 billion, which are the fruits of Mr Iwata's efforts to raise the funds, will be used for the JFCC's initial preparation to start its business. My question is how are you going to raise the operating funds for the Nagoya center after it has started operating? Could you elaborate on this?

Nakano: In connection with that question, Mr Iwata referred in an earlier part of this interview to the differences between a governmental research institution and our fine ceramics center. In my opinion, in operating the Nagoya ceramic center, we feel the necessity to introduce the business psychology or practices of private-sector enterprises to a certain degree. Unless we introduce this, there is a possibility that the operation of the center will become stagnant in the end. It could be said that one reason we decided to run the JFCC as a corporation is to avoid inviting such a situation occurring in the operation of the center.

Iwata: The operation of the center must pay.

Suzuki: Is one of the requirements in running the center to make the business pay...?

Nakano: That's right.

Iwata: The Nagoya ceramic center would not be permitted to be an institution which serves only to amass deficits. We are required to stand on our own feet in the operation of the center by profitably using the ¥8 billion in funds, most of which we have secured by now. This is the basic thing.

Because of this necessity, we must charge fees for the consultant service the JFCC will provide. But not all the information services the ceramics center will offer will be charged for. This position of intending to charge fees for many of the services the center will provide is based on our efforts to make the Nagoya ceramic center a self-sustaining institution. We don't want the center to be a research institution which will be run by contributed funds. In this respect, the JFCC will be an institution which is a little different from a state-run research institution.

Suzuki: Mr Iwata, what I have been trying to ask since you revealed a while ago that a fund would be created using the money contributed is this: Are you going to confine the activities of the JFCC within the budget equivalent to the total of the dividends and interests which would be generated by operating the fund money amounting to some ¥8 billion?

Iwata: No, because a large part of the contributed fund money will have been used up in the initial stage of the establishment of the Nagoya center.

Nakano: To try to raise the necessary operating funds through the business of the center itself is one of the features of the center.

Iwata: The ¥8 billion we are raising will not be left unused after we collect all of the targeted sum. In fact, we have already spent some of the funds already collected. We must spend several billion yen to prepare for the establishment of the JFCC.

Suzuki: Then, in a sense you are tackling your task of establishing the center with a resolve of burning your own boats if things turned out for the worst....

Nakano: The total costs of buying the land for the Nagoya center, for constructing the JFCC buildings and for procuring equipment for the center will come to ¥7 billion. While on the revenue side we are expected to be able to raise a total of ¥11 billion--the aforementioned ¥8 billion plus a total of ¥3 billion in subsidies from the local governments of one city and three prefectures, as mentioned in earlier part of this interview. So, this means that when we paid ¥7 billion for the land, buildings and equipment, ¥4 billion would have been used up from the ¥8 billion fund which we plan to establish using the contributed money.

By deducting the ¥4 billion to be spent from the ¥8 billion, we get ¥4 billion left. Supposing we try to run the Nagoya center with interest revenues generated on the ¥4 billion fund, the revenues from the interest payments are only about ¥250 million per annum when the interest rate stands at 6 percent per year. This revenue size is too small for the center to do anything meaningful in its activities. This makes it necessary for the center to try to raise its operating funds through its own efforts.

Suzuki: I am relieved to hear that. I believe it may sound funny to you, Mr Iwata and Mr Nakano, to hear a word of relief coming from me. (laughter) Without such a whip to....

Iwata: You are right. It is true that without a whip, the operation of the JFCC would be very difficult.

Nakano: I believe there may be almost no similar institutions in the country which are bold enough to invest as much as ¥4 billion from the first as we have done. We are all determined to work hard in running the JFCC. I think that such a determination of the people involved in the management of the center can also be regarded as a feature of the Nagoya ceramics center. It would be impossible to run the ceramic center properly without our working hard for the self-sustenance of the center.

Iwata: We know it is not easy to run the center. To keep the operation of the center viable, the number of clerical workers there must be kept as small as possible.

Suzuki: Then you believe the researchers working at the JFCC are also required to be cost-conscious, at least to the degree of about a half or so of what private-sector workers are required....

Nakano: Yes. Those researchers working at the Nagoya center must be highly cost-conscious people.

Iwata: At the present juncture, I don't know whether or not we will be able to run the center, but I am sure that all of those to be involved in the operation of the center must be cost-conscious, at least to a certain degree.

This is because money will not flow in automatically without our making efforts to make money.

Suzuki: Then it is your intention to try to supplement the revenue of the JFCC with money you expect to accrue from offering the data-base and consulting services which the center would be able to do in time after it starts its operations?

Nakano: Yes We regard our program to establish the JFCC as the first case of the government's effort to exploit private-sector resources. Prime Minister Yasuhiro Nakasone also calls our project the No 1 example of the efforts to use private-sector industry.

The standards must be established for those new industrial materials. After the JFCC starts operating we intend to tackle the business of establishing the standards. We believe that establishing the standards is a task which must be handled by the government, but we decided that we will do the job in place of the government.

Suzuki: You mean your institution does the job for the government after the center has been entrusted with the job by the government by receiving the fees for the task?

Nakano: Further negotiations must be held with the government regarding the question of whether we can receive the fees or not.

Suzuki: Isn't there any possibility that your center would be forced to do the job without any fees paid in the end?

Nakano: Whether we would be paid or not, to tell the truth, the work involved in establishing the standards would serve as the base of our testing research at the JFCC. Of course we would be glad if we could receive subsidies for our job, and when such subsidies are granted, we want the sum to be as high as possible. But even if our doing the job of establishing the standards resulted in our center's losing a bit of money, we would be willing to take the loss considering the fact that performing the job would be beneficial to our research.

Suzuki: The job can be regarded as a kind of work for creating the data base, can it not?

Nakano: Yes, it can. We have decided to carry out the job of establishing the standards for the government. Generally speaking, a juridical foundation can be said to be an entity which can rely on other entities for its existence. The JFCC is a juridical foundation. But despite this, we intend to run the ceramic center not relying on others, but with the intentions and based on the basic principles which have been clarified in our explanations given so far.

This is what Mr Iwata as chairman of the JFCC has emphatically been saying to me. We are all agreed on these intentions and principles.

In an effort to materialize our intentions, we plan to introduce the kinds of equipment into the JFCC which would allow us to provide adequate services of evaluation and analysis for outside customers. And I wonder if I can use the expression "to develop the demand" in connection with our customer-finding efforts, but I think we would also be able to make an effort to obtain customers for our service. I believe we could recruit the researchers who are able to take care of such service.

Suzuki: Then my impression is that the people at the Nagoya ceramic center will be required to endure the hardships which they are expected to experience when they start working at the center for at least 10 years or so before the center can tide itself over the initial difficulties....

Nakano: They probably must persevere for that long.

Iwata: I expect that in the course of those 10 years or so, some people at the JFCC will quit and new people will come in. I'm sure such movements of people will occur. The problem we must tackle is how to maintain continuity at the center when such personnel movement takes place.

Suzuki: Mr Iwata and Mr Nakano, I hope you will continue your endeavors in establishing the Japan Fine Ceramics Center, which, as you have said, will begin as the first model of government-led efforts to exploit private-sector resources. Thank you very much for taking time off your busy schedules for today's interview.

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NUCLEAR DEVELOPMENT

# STATUS OF RADIOACTIVE WASTE TREATMENT TECHNOLOGY UPDATED

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[Article by Akio Yuki, official in charge of policy and planning, Atomic Energy Bureau, Science and Technology Agency]

[Text] Nuclear power stations produce a variety of radioactive wastes not only while in operation, but also when they are decommissioned and dismantled. The processing and disposal of such a variety of radioactive wastes in a way that is appropriate for the kind of radioactive material, radioactive density and properties of the waste involved is looming as an important task.

In considering treatment and disposal of radioactive waste, it is important to keep in mind the following principle: first consider the final form of disposal, then, process the radioactive wastes in a way most suited to their final disposal.

On the issue of the disposal of low-level radioactive waste, much research has been conducted under the policy of a simultaneous disposal of waste on land and in the oceans. Ideas on how to go about disposal on the ground have been firming up in the past few years, and the construction of concrete projects is being promoted in Rokkasho Village, Aomori Prefecture. The required technology for radioactive waste disposal on the ground is almost complete, and from now on the emphasis in technical development will be on efficiency and economics.

As for high-level radioactive wastes, generated by reprocessing plants in the form of waste liquids, the basic policy for their disposal is vitrification, which is followed by the storage of the produced glass ingots for several tens of years for cooling and final disposal in the depths of the ground. For the technology to become feasible, research and development needs to be promoted for a long period of time on a planned and systematic basis. Therefore, the research and development is to be undertaken as an important national project, with the goal being construction of a demonstration plant incorporating the disposal technology by about the year 2000. The technology of vitrifying high-level waste and storing the glass ingots has been successfully put into practical use in France and other countries. In Japan, plans for the construction of a vitrifying plant for high-level radioactive waste and a storage plant for the produced glass ingots are materializing for high-level radioactive waste discharged from the reprocessing plant in Tokai-mura Village.

Among the types of radioactive waste are included the "TRU waste," a kind of waste discharged from reprocessing plants or plutonium fuel reprocessing plants, in which the radioactivity level is low but radioactive nuclides having an extremely long life are present. It is the kind of radioactive waste expected to be generated in the future, accompanying the dismantling of reactors, which, although low in their radioactivity level, have high concentrations of radioactivity. As planned now, disposal of these types of radioactive waste will be by one of the aforementioned disposal methods, one for high-level radioactive waste and the other for low-level radioactive waste, or both, or by some intermediate technology.

The following describes in depth the current state of radioactive waste treatment, disposal technologies and their prospects.

Ground disposal low-level radioactive waste

The nuclear power plants in operation have been producing about 50,000 drums of low-level radioactive waste per year. These drums are kept in storage on the premises of the nuclear power plants, and as of the end of March 1985, there were about 580,000 drums nationwide. The volume of radioactive waste is expected to keep increasing as new nuclear power plants come on line or capacities of the existing power plants are increased. But, on the other hand, development of the technology in the fields of reduction of the volume of radioactive waste generation and more efficient disposal of radioactive waste has been making progress, and the total volume of radioactive waste has been making progress, and the total volume of radioactive waste generated by all nuclear power plants in Japan is expected to reach about 1.55 million drums by the year 2000.

Although large in volume, low-level radioactive wastes contain low levels of radioactivity, to begin with. Moreover, the majority of radioactive wastes from nuclear power plants are substances with relatively short half-lives such as cobalt-60. In the case of cobalt-60, with a half-life of about 5 years, the radioactivity is reduced to one-half in 5 years, to about a one-thousandth in 50 years and to about a one-millionth in 100 years.

The land disposal of low-level radioactive waste takes advantage of the effect of the radioactivity that diminishes with the passage of time. Using this method, the level of human control is reduced in stages as attenuation of the radioactivity progresses, ultimately reaching a stage where human control is not needed at all. Specifically, the process is considered to go through the following four stages: In the first stage leakage of the radioactivity is checked by using drums or concrete pits (artificial barriers); in the second stage full safety evaluations are conducted, and even if a leakage occurred through the artificial barrier, contamination of the surrounding area outside the depository would be prevented by the soil in or around the disposal site (natural barrier); in the third stage monitoring of the surrounding area is no longer needed, and access to the disposal site is limited or excavation there is prohibited; and in the fourth stage no control is needed at all.

In line with such thinking, construction of facilities for land disposal of radioactive waste is underway by the electric power companies and others in Rokkasho Village, Aomori Prefecture. According to that plan, the facilities are scheduled to begin around 1991 to accept delivery of about 50,000 drums of low-level radioactive waste a year, from the nation's nuclear power plants. Their initial capacity is 1 million drums, but the storage capacity is to be increased to 3 million drums ultimately.

The progress of the project is being watched with great expectation, as it marks a great advance in the nation's effort for disposal of low-level radioactive waste.

Classification of low-level radioactive wastes and their rational disposal according to radioactivity levels

Radioactive wastes labeled as low-level include various types of waste, i.e., those that are already of a radioactivity level, extremely low waste whose radioactivity level has gone down due to attenuation of the radioactivity with the passage of time while it has been kept in long-period storage, those with extremely low radioactivity level, or those that are actually difficult to recognize as radioactive materials. In particular, the huge mass of concrete blocks, metal pipes and other materials which will be produced in large quantities as old reactors are dismantled in the future, is expected to be made up of the types of low-level radioactive waste mentioned above.

Consequently, the so-called low-level radioactive waste is to be classified, in descending order, into three categories: "waste that need not be treated as radioactive waste," "extremely low-level radioactive waste," and "low-level radioactive waste." As for wastes in the "extremely low-level radioactive waste category, their land disposal can begin in the third stage of the previously mentioned four stages of land disposal of low-level radioactive waste, and under certain conditions, concrete may be recycled as land-fill material and metal piping as raw material or resources.

The proper classification of low-level radioactive wastes is expected to open the way for their rational disposal in ways that are commensurate with their levels of radioactivity. Studies in fact are being made in the Atomic Energy Safety Commission on how to classify radioactive wastes and yardsticks for classification.

Disposal of high-level radioactive waste in geologic formations

For disposal of high-level radioactive waste (glass solidification), a method is under consideration in which vitrified radioactive waste solids will be stored above ground for 30 to 50 years until their heat emissions have dropped to a certain level. They will then be buried in rock beds, more than several hundred meters underground. Called the geologic formation disposal, research and development is being energetically conducted in various countries of the world toward the realization of this technique, with activity being augumented by the effort to select disposal sites.

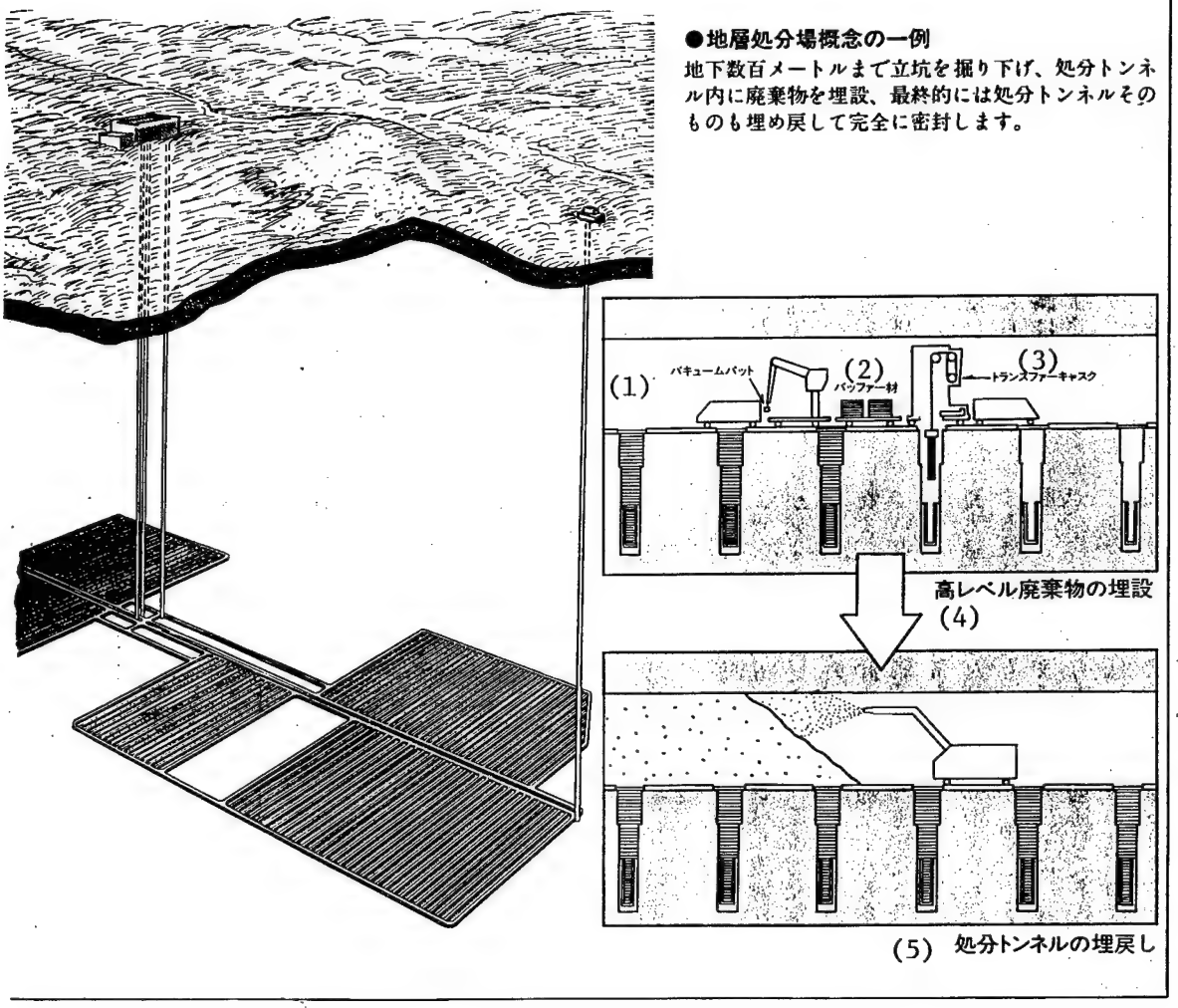
The Nuclear Energy Agency of the OECD had convened specialists from various countries to study the feasibility of geologic formation disposal, and in a report made public in January of this year the NEA states, "Specialists of the world are fully convinced that designing safe disposal sites in geologic formations, and operating them is feasible."

Research and development of geologic formation disposal in Japan has been promoted by the Power Reactor and Nuclear Fuel Development Corporation and the Japan Atomic Energy Research Institute. An August 1984 report by the subcommittee on radioactive waste of the Atomic Energy Commission, which is based on an evaluation of research results mentioned above, states, "In the case of Japan, a wide difference is observed, even among the same kind of rocks. There is a question as to whether they are suited as a depository for geological formation disposal depending on the geological condition in which they are deposited. So, a bright prospect has been gained for realizing the safety of a geologic formation disposal system not by specifying the kinds of rock but by designing the necessary man-made barriers as the geological condition demands it."

The geologic formation disposal technology is a system of comprehensive science technologies incorporating not only such scientific disciplines as geology, underground hydraulics and earth chemistry but also civil engineering technology. Also, much is unknown about the deep interior of the earth. Luckily, high-level radioactive wastes need to be stored above ground for a substantial period of time while they cool down, so there is ample time before the actual burying of high-level radioactive waste in a geologic formation is undertaken.

This period should be taken advantage of in promoting research and development of the technology for disposal in geologic formations on a planned and systematic basis. While making further efforts for research and development and striving for construction of a fullfledged underground experimental facility (deep geologic formation experimental station), the Power Reactor and Nuclear Fuel Development Corporation is to conduct, over a period of 10 years or so, a survey of the entire nation for candidate sites for disposal. Thereafter, an underground tunnel is to be dug at a candidate site for radioactive waste disposal, to conduct demonstration tests of the disposal technique. According to the plan, from around the year 2000 high-level radioactive waste is to be carried into the disposal site for further refinement of the disposal technology.

As can be seen, research and development of the geologic formation disposal technology is a big project requiring a long period of time, so the project needs to be undertaken by mobilizing all resources of concerned organizations such as the Power Reactor and Nuclear Fuel Development Corporation and the Japan Atomic Energy Research Institute. The government therefore is to promote the subject as an important national project beginning in FY 1985.




Schematic Diagram of Geologic Formation Disposal

A shaft is drilled to a depth of several hundred meters underground, radioactive waste is buried in the disposal tunnel, and finally the disposal tunnel itself is refilled with earth for an air-tight seal.

Key:

1. Vacuum pad
2. Buffer material
3. Transfer cask
4. Burying high-level radioactive waste
5. Refilling the disposal tunnel with earth

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NUCLEAR DEVELOPMENT

## HIGH EXPECTATIONS FOR LASER URANIUM ENRICHMENT DEVELOPMENT NOTED

Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 1 May 86 p 5

[Text] The aim is a steep cost reduction for enriched uranium. Development of laser enrichment technology has temporarily been reduced in developed countries, but on 21 April 1986, the Japan AEC's Working Group on Laser Methods and Technology (chairman of Investigation Committee, Keiichi Ootori, emeritus professor, Tokyo University) settled on an urgent program for Japan, as was acknowledged at the same meeting. A summary is introduced in this issue.

### Present Situation: A Fundmaental Stage

### Secret Technology Will Be Independently Developed

This working group, set up at the Japan AEC uranium enrichment meeting, held hearings from participants regarding the atomic and molecular uranium enrichment technologies in order to grasp the present situation, highlight problems, and promote development.

This technological development is at a fundamental stage in Japan, and a forecast of the outcome of further development is still awaited; however, the results of the Working Group's study of information on the present stage is collated below.

The laser methods of uranium enrichment are expected to provide big cost savings, and development is already progressing in the United States and France. In Japan, uranium enrichment enterprises are seen as necessary, in the long term, in order to maintain competitive power by possessing a low cost technology which is a match for the advanced uranium enrichment technologies of foreign countries; for this reason, promotion of technological development is important.

Laser methods are being realistically developed internationally, and are seen as a promising next generation technology for the important and delicate technology of uranium enrichment for the development of nuclear energy. This is very important in Japan, both as a principal nuclear energy development country and for national security.

Laser technology in laser methods of uranium enrichment particularly requires variable wavelength lasers of high output, and holds the strong possibility of producing breakthroughs in other fields of science and technology.

Moreover, molten metal, electron beam, dilute liquid, and other technologies are attracting attention as possible future growth technologies. The laser method of uranium enrichment has an important part to play in accelerating the development of these frontier technologies.

Research on the atomic method is in progress in Japan at Osaka University, JAERI [Japan Atomic Energy Research Institute], etc., and high separation coefficients have been observed. Since 1984, fundamental engineering experiments have been in progress, in a 6-year plan up to 1989.

The manufacturers, on the other hand, are advancing the development of their own research into copper vapor lasers, excimer lasers, etc., in the machine shop, in contrast to the research in JAERI.

Research has been carried out aimed at the atomic method, narrowing down the object, in the United States and France for a number of years; in contrast, research in West Germany has adopted the molecular method.

In Japan so far, private industry has performed virtually no private research into the molecular method; the main physicochemical research in progress has been centered on the 3-year plan from 1985 for theoretical and corroborative research.

Experimental and theoretical research on a high efficiency, high output Raman laser met with success recently at the Physicochemical Research Institute, ahead of many foreign countries; from now on, by uniting this with fundamental research on supersonic molecular flow, it is thought that economic uranium enrichment is possible.

Its development potential may be seen from a comparison of carbon dioxide laser technology for treatment of uranium hexafluoride; correspondingly, this potential will in the future have to be enhanced by the technology of repetitive selective excitation with a high output laser and a large supersonic nozzle device.

The United States has already reached the stage of plant scale confirmation of the laser method of uranium enrichment. In Japan, the progress of domestic and foreign laser technology for plant use is being considered, and research and development in many directions is necessary. Besides this, the conditions and circumstances are different in the United States and Japan regarding the necessity for the reutilization of retreated and recovered uranium, and the scale of the demand for enriched uranium.

However, in the development in Japan it is desirable, and from an independent standpoint timely, for research and development to be advanced, efficiently, step by step, and for periodic reviews to be performed. And in addition the level of technology in many foreign countries should be sufficiently probed.

Urgently attaining the next technological level in the atomic and molecular methods is considered to be the next appropriate objective.

Atomic Method

Corroboration of a suitable kilograms per year SWU [separation work unit] for enrichment, in an early stage, of about 5 percent will be obtained as soon as possible by continuation of fundamental engineering experiments and the preparation of a database.

Further, capital is scarce in Japan, and it is necessary to ascertain whether it is possible to apply it to the reenrichment of uranium recovered from retreatment; an investigation into this will commence.

It is important to approach, as soon as possible, the technological level of the United States and West Germany: thus technological development efforts will be concentrated on increasing the scale of plants in an experimental system providing about 5 percent enrichment at a suitable tons/year level, so that by about 1990 the engineering problems of bringing about a practical application will have been investigated.

Molecular Method

Continuation of the physical evidence experiments will be pursued, and by about 1987 it will be confirmed that enrichment of about 5 percent is physically possible.

Further endeavors, based on these results, will be, by about 1990, to carry out an evaluation in comparison with the atomic method.

Research Association Type of Development, Centered on Electric Power Companies: Atomic Method Actively Promoted

A broad concentration of technological power has not been approved for the development of the laser method of uranium enrichment; in the United States, the Department of Energy has announced that it is considered to be a markedly more intensive method than the centrifugal method. Hitherto, it was considered necessary to have increasingly efficient research and development endeavors over the long term, and an acceleration of industry, science and government collaboration.

In carrying out the research and development efficiently while providing for cooperation of private enterprises under JAERI, it will be desirable for regulation of research to be sufficiently based on the ideas of those concerned, and for a review of the effect of performance checks.

It is thought that carrying out the technology of uranium enrichment by laser methods will be important nationally.

(1) It will be very important to discover detailed data relating to uranium wavelengths, etc., and to set up a database on the material properties of the

uranium atom, uranium hexafluoride, etc., and also to continue corroborative experiments on engineering fundamental tests and theory.

(2) Apart from those for the maintenance of security and for optimum management of sensitive information, measures will be adopted to structure the development system efficiently by cooperation between the production, technical and management sides, to support private technological development in industry.

Moreover, as regards the technology of reenrichment of recovered, retreated uranium by laser technology, fundamental research will be performed, and also investigations in relation to the whole of the Japanese nuclear power development plan.

(3) To promote science and technology, both from the promotion of laser research as the option for the application period in uranium enrichment, and also from broadly contributing laser research and development in other fields, in equal proportions.

Atomic Method

In the atomic method, in Japan, besides the fundamental testing being continued at JAERI, efforts will proceed to prepare a database of fundamental data relating to the mutual action of laser light and uranium vapor, etc. Also, in the power reactor and nucear fuel development enterprise groups, based on present experience, research will advance on the properties of metallic uranium.

Moreover, private industry, and in particular electrical enterprises, as the ultimate beneficiary, are very interested in the actively advancing development in the United States and France, and, at the risk of proper personal responsibility, are eager to tackle it.

Thus it is thought desirable, from the viewpoint of making the most of private industry's vigor, and for machinery to be developed, for the electrical enterprises, aiming at practical application of uranium enrichment projects, to make use of the manufacturers in order to carry out system experiments corresponding to a ton-year-SWU degree of enrichment.

This plan is limited in contents and aim, and is to perform precise and urgent technological development, but in actual practice, from the point of view of the organization of the technological management system and of harmonious cooperative relationships and the external research system, the research association system is thought to be of effective practical use when set up in a corporate form.

When technological development is promoted by a research association, on the one hand, in order to try to introduce the competitive principle, while close contact will be maintained with research in JAERI, it is thought appropriate to pay heed to efficient development by provision of technical support such as

providing fundamental data from the nuclear fuel development group and the university system.

On the other hand, for the application of reenrichment to uranium recovered from reprocessing, it is possible that the technology will differ on the plant scale, and as regards the sorting excitation spectrum, from the conventional laser methods of uranium enrichment. This requires fundamental on-the-spot investigation, and is desirable to pursue as the main component of urgent research in Japan.

Moreover, regarding security measures for uranium enrichment on an industrial scale, and taking note of the example of the case of the centrifugal separation method, where equality of nuclear weapon countries and nonnuclear weapon countries was preserved. Careful dealings kept commercially valuable information secure, so consideration is necessary for the application of an international security system, in order to realize a commercial plant-scale laser method which is economic in Japan.

Summarizing the above, in the light of future results of research and development over several years, centered on private industry with a narrowed-down target, and sufficiently paying attention to Japan's long-term needs and to the international nonproliferation aspects, with a moderate total compensation, the policy of establishing a system of cooperation with private industry will be reconsidered, to see whether it will be necessary to modify the system of private cooperation.

Molecular Method

As regards the molecular method, corroboration of theory will be urgently advanced, using the abudant experience in the Physics Research Institute on the treatment of uranium hexafluoride, and obtaining the cooperation of the Power Reactor and Nuclear Fuel Development Enterprise Group; database preparation will be pursued, and in relation to these results the atomic method will have to be investigated as regards promotion systems, etc.

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CSO: 4306/2077

SCIENCE AND TECHNOLOGY POLICY

# SCIENCE AND TECHNOLOGY AGENCY FISCAL 1986 POLICIES

Tokyo PUROMETEUSU in Japanese Nov 85 pp 86-92

[Article by the General Affairs Division, Director-General's Secretariat, Science and Technology Agency: "Introduction of Policies To Be Implemented by the Science and Technology Agency on the Basis of the Regular August 'Key Policies' Prepared by the Agency"]

[Text] For Japan to advance toward further progress in the 21st century, it is important to create original technologies, and it has become necessary to contribute to the revitalization of the world economy and to the further progress of mankind by the stepped-up evolution of international cooperation in science and technology.

Fiscal 1986 policies will be implemented under the guideline of the report by the Council for Science and Technology "On Integrated Basic Measures for Science and Technology Promotion From the Long-Term Standpoint, Responding to New Changes in Situations," and also based on the report by the Council for Temporary Administrative Reform Promotion "Establishment of Science and Technology Policies and Reorganization of Their Integrated Furtherance System." Thus, a more positive science and technology administration will be evolved, especially placing emphasis on creative, basic research with the following as basic policies to be implemented: 1) reinforcement of integrated planning coordinating function; 2) reinforcement of industrial, academic, and governmental cooperation; and 3) positive contribution to the international society.

## 1. Furtherance of Creative, Basic Research by Industrial, Academic, and Governmental Cooperation

It is necessary to discover new scientific knowledge and step up efforts to produce creative technologies beyond the level of mere improvement of conventional ones by the furtherance of creative, basic research to foster next-generation technologies. And, since R&D in recent years has become sophisticated and complicated and has expanded into complex frontier areas, in order to push them forward it is indispensable to promote research exchange positively between different sectors beyond the framework of individual research organizations.

From such a point of view, the following measures are to be taken:

(1) Furtherance of frontier research (leading, basic research)

For Japan to develop science and technology toward the 21st century, it is indispensable to discover totally new scientific knowledge to be the basis of technological innovation which is buried in areas covering many sectors. For this, the International Frontier Research Organization (tentative name) is to be set up independently in the Institute of Physical and Chemical Research as an organization to perform leading basic research in the frontier internationally, flexibly and in the long-term by joining researchers of many sectors.

(2) Expansion of the science and technology promotion coordination expenditures

In accordance with the policy of the Council for Science and Technology, the science and technology promotion coordination expenditures are to be expanded to further comprehensively basic, leading, important research with the cooperation of industries, administrations, and academics. Efforts will be made in particular to expand the key basic research system set up in fiscal 1985 and further positive participation in international research exchange and research activities by young researchers.

(3) Expansion of the creative science and technology furtherance system

Efforts will be made to expand the creative science and technology furtherance system by initiation of research on three new themes which aim at furthering research to create seeds of original science and technology, the basis of technological innovation in the next generation, by organizing excellent researchers from industries, administrations and academia for a certain period of time under the project leaders.

(4) Foundation of a high-tech consortium system

Efforts will be made to form a high-tech consortium participated in by researchers of national research institutes and private enterprises of various types of businesses centering around the Research Development Corporation of Japan on the basis of fundamental patents applied for based on research results by the creative science and technology furtherance system, national research institutes, and colleges and universities, and evolve it toward new technologies such as peripheral patents.

(5) Promotion of research exchange such as collaboration

For efficient, effective furtherance of R&D in research institutes attached to the agency, efforts will be made to set up a governmental and private specified collaboration system, and expand and reinforce the guest researcher system.

(6) Enactment of a research exchange promotion law (tentative name)

For the promotion of research exchanges among industries, administration, and academia, efforts will be made to enact a research exchange promotion law (tentative name) involving legal measures necessary for positioning research exchange in science and technology promotion, regulation of governmental roles, promotion of joint R&D irrespective of the frameworks of industrial, academic, and governmental research organizations and realization of an internationally open research organization.

2. Readjustment of the Basis for R&D

Along with rapid progress in science and technology, not only securing creative personnel but also the basis to support activities related to science and technology have become increasingly important. For this, efforts will be made to readjust various data bases to promote research into leading, important science and technology sectors centering around the Japan Information Center of Science and Technology, and information distribution systems such as development of a new on-line information system (JOIS-III) and, at the same time, reinforce international response by initiating the construction of an international science and technology information network and readjustment of mechanical translation systems on a practical scale.

And, for early reinforcement of collection, preservation, and presentation systems which are behind other countries in their readjustment, efforts will be made to push the gene bank project of the Institute of Physical and Chemical Research and perform investigations necessary for the furtherance of preservation measures for resource plants.

3. Positive Contribution to the International Society Through International Cooperation in Science and Technology

In view of the situation of growing importance in international exchange, efforts will be made to respond positively to international cooperation in science and technology agreed at the summit meeting, and with ASEAN and further cooperation based on bilateral agreements centering on such sectors as nuclear R&D application, space and marine development and life science. For a reinforced personnel exchange between Japan and developing nations, in particular, efforts will be made to expand the invitation and detachment system for researchers.

4. Furtherance of R&D of Leading, Important Science and Technology Sectors

(1) Furtherance of nuclear R&D application and safety measures

As for R&D applications of nuclear power, it is imperative to enhance safety assurance measures, promote acquisition of sites for nuclear facilities in order to realize their establishment and steady furtherance with the understanding and cooperation of the nation, and further, from the long-term viewpoint, create policies on the establishment of the nuclear fuel cycle and develop new type power reactors and research into nuclear fusion. For

this, efforts will be made successively to enhance and reinforce nuclear safety measures such as improvement of the nuclear safety regulation administration, furtherance of safety research and reinforcement of measures to prevent disaster and radiation damage.

With a view to responding exactly and to make efficient progress in the application of nuclear R&D, in particular, efforts will be made to readjust various standards, enhance efficient inspection systems and, at the same time, further readjust and improve laws on safety regulations in the treatment and disposal of radioactive waste.

For the establishment of an autonomous nuclear fuel cycle, efforts will be made for overseas uranium survey and exploration activities, construction of uranium enrichment prototype plants, technical development for uranium enrichment by the laser method, demonstration and establishment of reprocessing technology and furtherance of radioactive waste treatment and disposal measures, as well as measures necessary for furtherance of the siting program for nuclear fuel cycle facilities in the private sector and promotion of its smooth commercialization. In addition, for efficient application of nuclear fuel, construction will be pushed ahead on the fast-breeding prototype reactor Monju and, at the same time, development will be furthered of new type power reactors to advance the new type converter and demonstration reactor program.

As for nuclear fusion, plasma experiments by the body of the critical plasma test equipment (JT-60) will be continued aimed at achieving critical plasma requirements in fiscal 1987 and needed R&D will be furthered. With regard to the nuclear powered ship Mutsu, efficient experiments will be made to obtain knowledge and data indispensable for R&D of marine reactors in the future, and construction of the new fixed basin needed for that will be successively pushed forward and necessary research conducted.

In the meantime, for further sophistication of radiation-applied technology, ion irradiation facilities will be reorganized in the Japan Atomic Energy Research Institute to further radiation high-tech research with the cooperation of industries, administrations, and academics, and the relevant research will be advanced in the National Institute of Radiological Sciences and the Institute of Physical and Chemical Research.

(2) Furtherance of space development

As for the development of space, a new activity area for human beings, it is necessary to further the development of artificial satellites and their launching rockets in the actual space application sectors such as communications, broadcasting, weather observation, marine observation, and earth resources observation.

For this, efforts will be made to develop an earth resources satellite No 1 (targeted for launching in fiscal 1990), with resources observation as its main purpose, aimed at observation of land survey, agriculture, forestry, fishery, environmental protection, disaster prevention, and coast area

monitoring, and at the same time, initiate R&D of a technical test satellite VI type aimed at technical development for high-level satellite communications and experiments and successively further development of various artificial satellites. To meet the demand for launching large artificial satellites in the 1990's following the development of the H-I rocket, the development will be initiated of the H-II rocket capable of launching a stationary satellite weighing around 2 tons, targeted for launching a testing model in fiscal 1991.

In the meantime, the development of an experimental system and training of scientific engineers will be successively furthered as being necessary for the first material experiment targeted for fiscal 1987 with a view to material experiment using space characteristics, such as microgravity to be conducted by Japanese scientific engineers on board the U.S. space shuttle. Furthermore, in order to take part in the preliminary design phase activity (phase B) of the space station program proposed by the United States, R&D will be furthered of the preliminary design of an experimental module.

(3) Furtherance of marine development

For promotion of the multilateral development application of the peripheral waters of Japan, development will begin on a 6,000-m class submersible research vessel indispensable for the survey of submarine mineral resources, such as manganese nodules, and submarine topography, and, at the same time, sea survey and study activities will be carried out by the Shinkai 2000 (2,000-meter maximum depth submersible vessel) and its support mother ship Natsushima, and an unmanned survey machine will be developed.

And, for furtherance of R&D of diving work technology targeted at a depth of 300 meters, actual sea area experiments will be pushed ahead using the submarine work experiment ship Kaiyo. Additionally, to further the development of comprehensive sea area utilization technology, the Aqua Marine Project will be advanced with the cooperation of the government and local public corporations.

(4) Response to an advanced-age society and promotion of life science

Efforts will be made to further R&D of science and technology responding to a rapidly nearing advanced-age society, one in which the aged are increasing in percentage. And, for the promotion of life science, comprehensive technology to contribute to the welfare of human beings in a wide range of sectors such as health and medical care, agriculture, forestry, and fishery and the mining industry, research and support projects will be conducted in the Institute of Physical and Chemical Research utilizing gene recombination experiment facilities provided with maximum physical containment functions. At the same time, leading, basic R&D of life science will be pushed ahead utilizing the International Frontier Research Organization, the creative science and technology furtherance system and the science and technology promotion coordination expenditures.

(5) Integrated R&D furtherance of material science and technology

R&D will be furthered on materials to be the basis of energy R&D, such as superconductive materials, and high performance functional materials, such as the semiconductor diamond, in the Metallic Material Engineering Laboratory and Inorganic Material Research Institute. Additionally, R&D will be positively advanced utilizing the International Frontier Research Organization, the creative science and technology furtherance system, and the science and technology promotion coordination expenditures.

(6) Furtherance of other important comprehensive research

As for disaster prevention technology closely related to people's daily lives, research will be furthered in the National Research Center for Disaster Prevention on earthquake prediction for the Kanto and Tokai districts, earthquake disaster measures and life-related snow damage prevention technology. With regard to aviation technology, full-scale flight experiments of Asuka, an experimental plane for the fan jet STOL (short take-off and landing) will be conducted, demonstration of various new technologies will be advanced and necessary R&D furthered.

5. Reinforcement of the Furtherance System of Science and Technology Policies

For the readjustment of the furtherance system of the abovementioned science and technology, reorganization of the agency's internal organization will be made, the National Institute of Resources reorganized into the "Integrated Policy Research Institute" (tentative name) and a system readjusted for investigation of conventional resources comprehensive application measures and for studies of science and technology related policies.

Fiscal 1986 Budget Approximation Request Table of the Agency of Science and Technology

(Unit: millions of yen; figures with an ● mark mean debt representing amount for treasury liability actions. Source: The Science and Technology Agency, August 1985)

| Division | Budget for previous year | Approximation request for fiscal 1986 | Increase/decrease (Δ mark) in comparison | Ratio over previous year (percent) |
|---|---|---|---|---|
| 1. General account | ● 93,090<br>329,529 | ● 136,114<br>334,390 | ● 43,024<br>4,861 | 101.5 |
| 2. Industrial investment special account | 2,900 | 4,500 | 1,600 | 155.2 |
| 3. Special account for power source development promotion measure | ● 89,168<br>88,478 | ● 46,416<br>94,786 | ● Δ 42,752<br>6,308 | 107.1 |
| (1) Power source location account | 12,124 | 12,500 | 376 | 103.1 |
| (2) Power source diversification account | ● 89,168<br>76,354 | ● 46,416<br>82,286 | ● Δ 42,752<br>5,932 | 107.8 |
| Total for the Agency of Science and Technology | ● 182,258<br>420,907 | ● 182,530<br>433,676 | ● 272<br>12,769 | 103.0 |

(General Account and Industrial Investment Special Account)
Main Contents of Budget Request

(Unit: millions of yen; figures with an ● mark mean debt represents amount for treasury liability actions)

| Item | Budget for previous year A | Request approximation for FY 1986 B | Increase/decrease (Δ marked) in comparison B-A | Remark | |
|---|---|---|---|---|---|
| 1. Furtherance of creative, basic research under cooperation of industries, administration, and academics | 10,205 | ● 1,133<br>● 13,144 | ● 1,133<br>2,939 | 122.8 percent | |
| (1) Furtherance of frontier research | 0 | ● 1,133<br>1,370 | ● 1,133<br>1,370 | Three sectors of phytohomeostasis, aging process and frontier materials | 901 |
| | | | | | ● 1,133 |
| | | | | Construction of central research and experimental building | 347 |
| (2) Expansion of science and technology promotion coordination expenditures | 7,100 | 7,900 | 800 | 111.3 percent | |
| (3) Expansion of creative science and technology furtherance system | 2,570 | 2,791 | 221 | 108.6 percent<br>Three new themes | |
| (4) Foundation of high-tech consortium system | 0 | 397 | 397 | Evolution of high technology | 229 |
| | | | | Promotion of acquisition of creative technology | 168 |
| (5) Promotion of research exchange such as collaboration | 535 | 686 | 151 | Collaboration between research institutes and enterprises | 103 |
| | | | | Invitation of guest researchers to research institutes | 35 |
| | | | | Domestic and overseas training of research related public officials | 474 |
| | ● 611 | | ● Δ 611 | | |
| 2. Readjustment of the basis for R&D | 4,949 | 6,545 | 1,596 | 132 percent | |
| (1) Promotion of science and technology information distribution | 4,666 | 6,196 | 1,530 | Japan Information Center of Science and Technology | 6,186 |
| (General account--Industrial investment special account | 1,766<br>2,900 | 1,696<br>4,500 | Δ70<br>1,600) | Expansion of data bases | 4,101 |
| | | | | Expansion of literature data bases | 3,309 |
| | | | | Expansion of on-line information service | 2,494 |
| | | | | Construction of international science and technology information network system | 541 |
| | | | | New on-line system (JOIS-III) | 252 |
| | | | | Readjustment of mechanical translation systems | 170 |
| | ● 611 | | ● Δ 611 | | |
| (2) Reorganization of systems for collection, preservation, and supply of gene resources | 283 | 349 | 66 | Construction of gene bank buildings | 218 |
| | | | | Microorganism system preservation and supply projects | 115 |
| | | | | Formulation and investigation of resource organism preservation measures | 15 |

[continued]

[Continuation]

| Item | Budget for previous year A | Request approximation for FY 1986 B | Increase/decrease (Δ marked) in comparison B-A | Remark | |
|---|---|---|---|---|---|
| | ● 16,004 | ● 13,619 | ●Δ 2,385 | | |
| 3. Furtherance of international cooperation in science and technology sectors | 30,438 | 34,046 | 3,608 | 111.9 percent (those rebudgeted from other items included) | ● 6,852 |
| | | | | Cooperation with advanced nations | 28,485 |
| | | | | | ● 800 |
| | | | | Cooperation with developing nations | 3,109 |
| Reinforcement and expansion of international personnel exchange | [1,551] | [1,909] | [358] | (due to rebudgeting from other items) | |
| | | | | Personnel exchange with advanced nations | 1,127 |
| | | | | Personnel exchange with developing nations | 538 |
| | ● 93,090 | ●134,981 | ● 41,891 | | |
| 4. Furtherance of R&D of leading, important science and technology sectors | 302,469 | 312,894 | 10,425 | 103.4 percent | |
| | ● 41,614 | ● 36,509 | ●Δ 5,105 | | |
| (1) Furtherance of nuclear R&D application and safety measures | 178,020 | 182,948 | 4,928 | 102.8 percent | |
| | | | | (the total amount including special account for power source development promotion measures | ● 82,925 277,734) |
| (a) Enhancement of administration for nuclear safety regulation and secured environmental safety | 2,054 | 2,141 | 87 | Research into radioactivity measurement | 1,023 |
| | | | | Safeguards and nuclear material protective measures | 523 |
| | | | | Efficient furtherance of safety regulation administration | 50 |
| | ● 9,780 | ● 9,355 | ● Δ 425 | | |
| (b) Power Reactor and Nuclear Fuel Development Corporation (PRNFDC) | 65,769 | 66,293 | 524 | (the total amount of PRNFDC including special account for power source development promotion measures) | ● 55,771 143,562) |
| | | | | | ● 8,766 |
| | | | | Development of power reactors | 44,001 |
| | | | | | ● 2,205 |
| | | | | Development of fast breeders | 16,668 |
| | | | | Development of a new type converter | 1,514 |
| | | | | Overseas survey and exploration or uranium resource | 4,979 |
| | | | | Development of uranium enrichment technology | 2,940 |
| | ● 30,704 | ● 27,154 | ●Δ 3,350 | | ● 7,371 |
| (c) Japan Atomic Energy Research Institute | 99,674 | 102,010 | 2,336 | Research into safety | 7,822 |
| | | | | | ● 6,296 |
| | | | | R&D of nuclear fusion | 35,748 |
| | | | | | ● 4,511 |
| | | | | Consideration of JT-60 and its experiment | 31,196 |
| | | | | R&D of multipurpose high temperature gas reactor | 5,631 |
| | | | | R&D of a nuclear powered ship | 9,336 |
| | | | | | ● 1,870 |
| | | | | Research into radiation high technology | 200 |
| | ● 345 | | ● Δ 345 | | |
| (d) National Institute of Radiological Sciences | 5,551 | 6,560 | 1,009 | Heavy corpuscular ray cancer treatment equipment | 881 |

[continued]

[Continuation]

| Item | Budget for previous year A | Request approximation for FY 1986 B | Increase/decrease (Δ marked) in comparison B-A | Remark | |
|---|---|---|---|---|---|
| (e) Tests and research by national laboratories and research institutes | 1,733 | 1,794 | 61 | General budgeting of nuclear test research expenditures by individual ministries and agencies | |
| | ● 785 | | ● Δ 785 | | |
| (f) Nuclear research by the Institute of Physical and Chemical Research | 2,545 | 3,438 | 893 | Construction of a heavy ion accelerator | 2,466 |
| | | | | Technical development of the uranium enrichment laser method | 175 |
| | ● 48,818 | ● 82,990 | ● 34,172 | | |
| (2) Furtherance of space development | 91,585 | 94,534 | 2,949 | 103.2 percent | |
| | ● 48,818 | ● 82,843 | ● 34,025 | | ● 1,900 |
| (a) National Space Development Agency | 88,861 | 92,572 | 3,711 | Development of the H-I rocket | 12,074 |
| | | | | | ● 41,829 |
| | | | | Development of the H-II rocket | 22,625 |
| | | | | Development of the marine observation satellite No 1 | 5,713 |
| | | | | Development of the technical testing satellite V type | 2,635 |
| | | | | | ● 821 |
| | | | | Development of the communication satellite No 3 | 4,676 |
| | | | | Development of the broadcasting satellite No 3 | 1,454 |
| | | | | | ● 5,830 |
| | | | | Development of the stationary weather satellite | 1,493 |
| | | | | | ● 8,523 |
| | | | | Development of the earth resources observation satellite No 1 | 3,752 |
| | | | | | ● 2,626 |
| | | | | R&D of the technical testing satellite VI type | 347 |
| | | | | Development of a primary material experimental system | 6,127 |
| | | | | Participation in preliminary design of U.S. space station program | 4,110 |
| | | ● 147 | ● 147 | | |
| (b) Space-related research by the National Aerospace Laboratory | 2,197 | 1,430 | Δ 767 | Research into liquid acid and water rocket engine elements for the H-II rocket | ● 147<br>588 |
| | | ● 12,500 | ● 12,500 | | |
| (3) Furtherance of marine development | 6,875 | 7,382 | 507 | 107.4 percent | |
| | | ● 12,500 | ● 12,500 | | |
| (a) Marine Research Center | 6,700 | 7,154 | 454 | R&D of deep-sea submersible research vessels | 4,043 |
| | | | | Construction of a 6,000-m class submersible research vessel | ● 12,500<br>1,958 |
| | | | | R&D of diving work technology | 1,626 |

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| Item | Budget for previous year A | Request approximation for FY 1986 B | Increase/decrease (Δ marked) in comparison B-A | Remark | |
|---|---|---|---|---|---|
| | | | | Operation of submarine work experimental vessel | 1,070 |
| | | | | (Marine Center's total | ● 12,500 |
| | | | | amount including budget for other items) | 7,187 |
| (b) R&D related to other life science | 175 | 228 | 53 | Research into development and application of the Kuroshio current | 122 |
| | ● 611 | ● 278 | ● Δ 333 | | |
| (4) Response to an advanced-age society and promotion of life science | 7,917 | 9,760 | 1,843 | 123.3 percent (Cancer-related research) | |
| (a) Furtherance of research into aging and science and technology responding to other advanced-age society | 327 | 581 | 254 | Research into aging process in frontier study | 176 |
| | | | | Estimates of appropriation from science and technology promotion coordination expenditures | 350 |
| | ● 611 | ● 278 | ● Δ 333 | | ● 278 |
| (b) R&D related to other life science | 7,590 | 9,179 | 1,589 | The Institute of Physical and Chemical Research | 1,950 |
| | ● 611 | | ● Δ 611 | Construction of gene bank buildings | 218 |
| Cancer-related research | 3,971 | 4,398 | 427 | | ● 278 |
| | | | | Construction of experimental animal maintenance facilities | 85 |
| | | | | Estimates of appropriation from science and technology promotion coordination expenditures | 1,850 |
| | | | | Estimates of consignment development of new technologies | 1,145 |
| | | | | Creative science and technology promotion system | 1,291 |
| | | | | Research into life science in frontier study | 170 |
| | | | | National Institute of Radiological Sciences | 2,422 |
| | | | | Medical application study of heavy corpuscular ray | 1,000 |
| | | ● 2,339 | ● 2,339 | | |
| (5) Overall furtherance of material technology R&D | 8,510 | 9,177 | 667 | 107.8 percent (rebudgeted amount from other items included) | |
| | | | | | ● 614 |
| | | | | National Research Institute for Metals | 4,096 |
| | | | | | ● 592 |
| | | | | National Institute for Research in Inorganic Materials | 1,775 |
| | | | | Appropriation estimates from science and technology promotion coordination expenditures | 2,100 |
| | | | | Creative science and technology furtherance system | 559 |
| | | | | Material study in frontier study | ● 1,133 647 |

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| Item | Budget for previous year A | Request approximation for FY 1986 B | Increase/decrease (Δ marked) in comparison B-A | Remark | |
|---|---|---|---|---|---|
| | ● 2,658 | ● 1,776 | ● Δ 882 | | |
| (6) Furtherance of other important comprehensive research | 20,389 | 22,159 | 1,770 | 108.7 percent | |
| | ● 203 | ● 1,285 | ● 1,082 | | ● 1,285 |
| (a) Furtherance of disaster prevention science and technology R&D | 2,091 | 2,589 | 498 | National Research Center for Disaster Prevention | 2,584 |
| | | | | Research into earthquake prediction | 913 |
| | | | | | ● 1,285 |
| | | | | Research into earthquake disaster measures | 549 |
| | | | | Research into snow damage | 116 |
| | ● 1,844 | ● 213 | ● Δ1,631 | | |
| (b) Furtherance of aeronautical technology R&D by the National Aerospace Laboratory | 7,813 | 8,589 | 776 | R&D of the fan jet experimental model of STOL | ● 213 3,769 |
| | | | | Introduction of a numerical simulator | 705 |
| | | | | (the total amount of the budget for the National Aerospace Laboratory, including that for space research) | ● 360 10,019 |
| | ● 611 | ● 278 | ● Δ 333 | | ● 278 |
| (c) Furtherance of other important studies | 10,486 | 10,981 | 495 | Institute of Physical and Chemical Research | 9,041 |
| | | | | (the total amount of the budget for the Institute of Physical and Chemical Research, including that for nuclear and frontier industry) | ● 1,411 13,849 |
| | | | | Research Development Corp. of Japan | 1,635 |
| | | | | (the total amount of the budget for the Research Development Corp. of Japan including that for creative science and high technology research) | 4,823 |
| | | | | Limited amount of the consignment developmental agreement | |
| | | | | Furtherance of overall resources application measures | 124 |
| | | | | Furtherance of publicity and enlightenment activities for science and technology | 171 |
| 5. Reinforcement of the furtherance system for science and technology | 304 | 406 | 102 | 133.6 percent | |
| | | | | Council for Science and Technology | 41 |
| | | | | National Institute of Comprehensive Policy, Agency of Science and Technology | 281 |
| | | | | Reinforcement of research and analysis function | 84 |

Power Source Development Promotion Measure Special Account

(Unit: millions of yen; figures with an ● mark mean debt represents the amount for treasury liability action)

| Item | Budget for previous year A | Request approximation for FY 1986 B | Increase/decrease (Δ marked) in comparison B-A | Remark | |
|---|---|---|---|---|---|
| (Power source location account) | 12,124 | 12,500 | 376 | 103.1 percent | |
| 1. Consignment cost for safety measures against nuclear power generation | 4,738 | 5,189 | 451 | Large resubmergence effect demonstration tests | |
| 2. Subsidy for power source location promotion measures | 3,659 | 3,864 | 205 | Reorganization of public facilities | |
| 3. Special subsidy for power source location | 1,319 | 1,390 | 71 | Subsidy for peripheral areas such as nuclear power generation | 1,008 |
| | | | | Subsidy for power exportation prefectures | 382 |
| 4. Subsidy for safety measures against nuclear power generation | 2,293 | 1,936 | Δ 357 | Subsidy for radiation monitoring | 1,300 |
| | | | | Subsidy for emergency safety measures for nuclear power generation facilities | 493 |
| | ● 89,168 | ● 46,416 | ●Δ42,752 | | |
| (Power source diversification account) | 76,354 | 82,286 | 5,932 | 107.8 percent | |
| | ● 89,168 | ● 46,416 | ●Δ42,752 | | |
| 1. Power Reactor and Nuclear Fuel Development Corp. | 72,013 | 77,269 | 5,256 | | |
| (1) Development of new type power reactors | ● 86,112 | ● 39,438 | ●Δ46,674 | | ● 35,485 |
| | 45,232 | 49,730 | 4,498 | Construction of the fast breeder Monju | 39,500 |
| | | | | R&D on the new type converter demonstration reactor | ● 479 3,305 |
| (2) Development of used fuel reprocessing technology | ● 2,719 | ● 4,535 | ● 1,816 | | |
| | 16,221 | 16,590 | 369 | Development of reprocessing technology | 9,026 |
| | | | | Development of processing technology for high-level radioactive waste | ● 400 1,545 |
| | | | | | ● 4,135 |
| | | | | Reorganization of reprocessing facilities | 338 |
| (3) Development of uranium enrichment technology | ● 336 | ● 2,443 | ● 2,107 | | ● 2,443 |
| | 10,560 | 10,949 | 389 | Construction of prototype plants | 5,972 |
| 2. General research | 4,327 | 4,998 | 671 | Development consignment of nuclear reactor demolition technology | 1,968 |
| | | | | Aids to development of radioactive waste processing and disposal technology | 611 |
| | | | | Development consignment of uranium enrichment technology by the laser method | 705 |
| Total | ● 89,168 | ● 46,416 | ●Δ42,752 | | |
| | 88,478 | 94,786 | 6,308 | 107.1 percent | |

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